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The temperature of a small stony stream

T. T. MACAN

Freshwater Biological Association, Ambleside, Westmorland,
England

With 5 tables and 10 figures in the text

Several workers (RICKER 1934, IDE 1935, SPRULES 1947) have used thermographs in streams, but none to my knowledge has considered it worthwhile to publish the results in full and to describe the general picture throughout a year, the difference between years, or the changes that take place each day according to the time of year and the weather. The writer hopes in the following pages to justify his belief that observations of this kind are not without interest to the biologist.

First the apparatus and the stream in which it was used are described, and then the records are examined under the following six heads: (a) seasonal trends, (b) the influence of sunshine and rain on high summer temperatures, (c) diurnal changes, (d) comparison with other places, (e) comparison of two years, and (f) comparison of stream and air temperature. Finally attention is devoted to the question of how much an observer provided only with a simple thermometer could have discovered.

ECKEL & REUTER (1950) and ECKEL (1953) have published theoretical studies of the factors influencing stream temperature. SCHMITZ (1954) has studied the temperature pattern during the course of a day at different points along a stream.

THE INSTRUMENT AND THE STREAM

The records were obtained with a mercury-in-steel thermograph supplied by the Cambridge Instrument Company. It was rather large and the only place where it could conveniently be set up was in a hut in the writer's garden though this situation, as will appear, was not ideal, being near the downstream end of an underground channel.

The instrument was installed and calibrated in the autumn of 1950, but few satisfactory records were obtained before January 1951.

Unfortunately the clock originally supplied was faulty and caused many gaps in the records before breaking down irreparably early in 1953. A new one was obtained in April 1954, after which the instrument ran continuously for three years.

The gathering-ground of the stream, Outgate Beck, is a flat saucer-like area somewhat less than 1 sq. km in extent. In the middle, where there was probably once a small lake, is a bed of peat forming what is known locally as a „moss”, a name that it is convenient to retain. The depth is unknown but it probably nowhere exceeds 2 or 3 m to judge from the contours of the rest of the basin. An artificial cut (A-B on fig. 5) runs through the peat and continues through an outcrop of rock. Beyond point B the bed of the stream is steeper and the current is swift enough to maintain a stony bottom everywhere. The vertical scale of fig. 5 is, however, schematic. As it becomes swift, the stream enters an artificial underground channel, at the end of which there is a short open stretch where the thermograph was located (point D). Beyond another short tunnel (D-E) is another open stretch in which there is a sudden and steep fall (G indicates the top) and then a third tunnel, at the exit of which (J) Outgate Beck runs into Ford Wood Beck. This has emerged from a man-made underground channel some 200 metres higher up and has received a long tributary.

THE EFFECT OF TEMPERATURE ON ANIMALS

Sudden extremes of temperature do not occur in water. In these latitudes it does not freeze, except at the extreme surface, and therefore the freshwater ecologist has not to consider the exceptionally cold night or the quick frost out of season, as the student of land animals must. Temperatures high enough to kill are more common but they rarely go high enough to kill quickly and their effect depends on the temperature at which the organism has been living previously (FRY, HART & WALKER 1946). Temperature acts mainly through its effect on rate of growth and reproduction and on time of breeding or hatching. It also influences other factors such as oxygen and salinity. The freshwater biologist is, therefore, generally as much concerned with how long a temperature has lasted, as with the actual level reached.

THE RECORDS

(a) The seasonal trends

Certain regular trends are discernible during the course of a year and four periods can be recognized (fig. 10). First there is the winter period of January and February when the temperature is at its

lowest and, though it may fluctuate considerably, shows little general tendency to rise. During fine weather the sun has hardly any power to warm the water but during the long cold nights radiation cools it, and accordingly fine weather is a period of low temperature. A rise comes when warm rain-bearing Atlantic air drifts in. The second period, extending from just before the equinox to just after the solstice is a period of increasing temperature. It is also a time of big fluctuations during fine weather, which, after a while, becomes the cause of the highest temperatures. The third period, July and August, is one of sustained high temperature and during it big differences between daily maximum and minimum are rare. The highest temperatures are reached in these two months in years when they are not continuously wet. Then the last period, till the end of the year, is one of steady fall with generally only small fluctuation during the course of a day, a difference of as much as 3°C between daily maximum and minimum being rare.

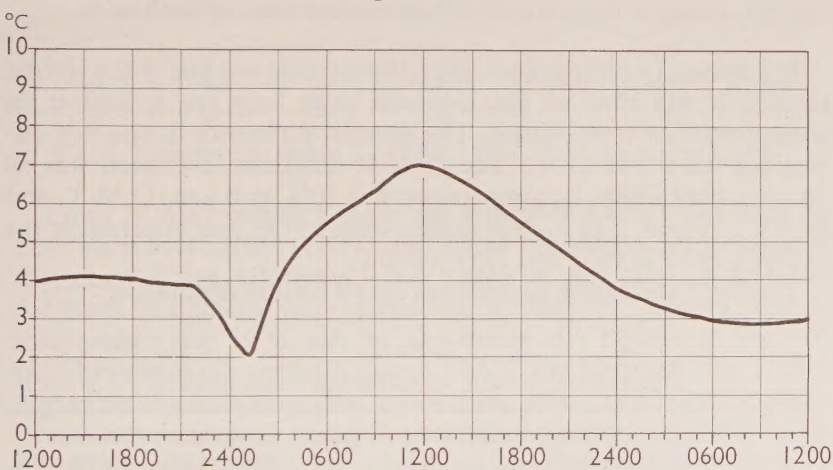


Fig. 1. Temperature record from noon on 9 Jan. to noon on 11 Jan. 1955

A few figures may be quoted to support these statements. Fig. 1, January 1955, provides an example of an extreme winter fluctuation. The weather was cold and, on 9 January, it began to snow, which lowered the water temperature to 2°C . The snow turned to rain which went on all next day and the temperature rose to a maximum of 6.9°C , a level not exceeded till late March. February of that year started warm with the temperature ranging between 4.6 and 6.0°C during the first five days, but, during most of the second week it was below 5°C , during the third it never rose above 3.7°C and during the fourth week it reached zero one night and never rose above 2.3°C . March was also cold and the temperature did not exceed the January maximum

till the last week. This was the coldest winter during the period when observations were being made. In 1957, the warmest, the temperature was seldom far from 5°C throughout January and February and it reached a maximum of 8°C near the beginning of the year. The stream has never been known to freeze, though occasionally there has been a surface coat of ice in places.

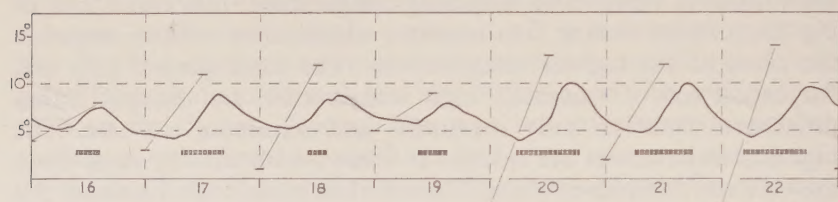


Fig. 2. Temperature record 16–22 April 1951. The short horizontal bars joined by oblique lines show maximum and minimum air temperature; each is shown at noon and midnight respectively, there being no record of the actual time of occurrence. Broad horizontal bars indicate hours of sunshine.

Fig. 2 shows a typical week when the weather was fine in the second period; at any time of year overcast skies keep the stream at an almost constant temperature. The greatest difference in one day during the week was 6.0°C. The greatest difference ever seen was on 16 May 1952 when the temperature was 10°C at 6 a.m. G.M.T. and 16.8°C at 5 p.m. The highest temperature of the year occurred in the second period in 1951 and 1954 (table I).

The third and fourth periods call for no further comment.

TABLE I
Dates when certain temperatures were reached

Year	10°C first reached	15°C first reached	max. temp.	date	last date above 15°C	last date above 10°C
1951	20 April	22 June	19.0°C	30 June	15 Sept.	18 Oct.
1952	10 April	c. 20 May	18.2°C	5 Aug.	—	—
1954	23 April*	27 May	16.5°C	31 May	15 August	1 Nov.
1955	11 April	15 June	18.7°C	13 July	14 Sept.	10 Nov.
1956	2 May	5 July	16.0°C	24 July	17 August	24 Oct.
1957	12 March	22 May				

* First reading of the year

(b) Influence of sunshine and rain on high temperatures in summer

Fig. 2 shows the beginning of a fine spell in 1951. The year was wet till 17 April and in fact there were but 17 days in the 107 between 1 January and that date when no rain fell and only three were conse-

cutive. The next two days were moderately sunny but, on 20, 21 and 22 April, 12.9, 12.1 and 12.9 hours of sunshine respectively were recorded at Ambleside. Temperature reached 10°C for the first time in the year and there were also big differences between maximum and minimum, just 6°C on 20 April. 18 April was the first day of a fine spell lasting a month, and fig. 3 shows the record during its fourth week, by which time the level of the beck was very low. It might be thought that a hot sun beating down on a small volume of water trickling sluggishly might produce a high temperature. The observations show that it does not. In spite of 14.1 hours of sunshine on both 10 and 11 May the temperature did not reach 10°C , the maximum attained 3 weeks earlier and the daily fluctuation was less than it had been at the beginning of the fine spell.

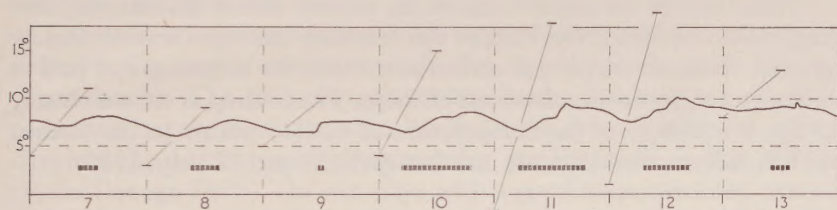


Fig. 3. Temperature record 7–13 May 1951. For explanation see fig. 2.

From 19 May onwards there was a little rain every day until the 24th when 0.44 inches (11.17 mm) fell at Ambleside. „Heavy rain all morning, sunny afternoon” was noted at the time at Outgate; 3.4 hours of sunshine were recorded at Ambleside. The maximum air temperature was 16°C , not by any means the highest of the year, but the stream temperature rose to 13.5°C the highest so far. It went higher on the following day, when there were 12 hours of sunshine.

It is unnecessary to multiply examples and from a number available only the one showing the conditions when the highest temperature recorded was reached has been selected (fig. 4). On five of the six days preceding 30 June 1952 a little rain had fallen. On that day local observations recorded drizzle in the morning, though no rain

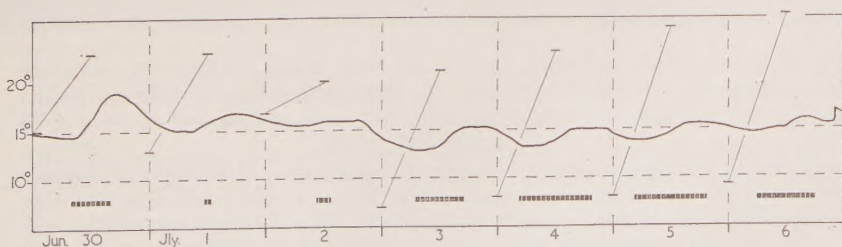


Fig. 4. Temperature record 30 June to 6 July 1952. For explanation see fig. 2.

was recorded at Ambleside. In the afternoon the sun came out and 8.2 hours were recorded at Ambleside. The maximum air temperature at Ambleside was 23°C, which was not an outstandingly high figure, but it was on this day that the stream temperature reached 19°C. Later in the week on sunny days it was nearly 4° less.

Evidently the highest temperatures do not occur in sunny rainless spells when the water-level is low, but are associated with sun shining soon after rain.

When the stream is low, the water feeding it, derived presumably from the lower layers of the soil, is relatively cold. When rain comes, there are probably two effects: first a high humidity prevents cooling of surface water by evaporation and secondly water flows into the stream from the warm soil near the top.

There can be no doubt that, in the stream under discussion, cooling would be less if the stream did not flow through several underground channels and it was unfortunate that the thermograph had to be located near the mouth of one of these. The cooling is shown clearly in fig. 5 which gives the temperature at various points in the stream on two consecutive days late in a fine spell (24 and 25 July, 1955).

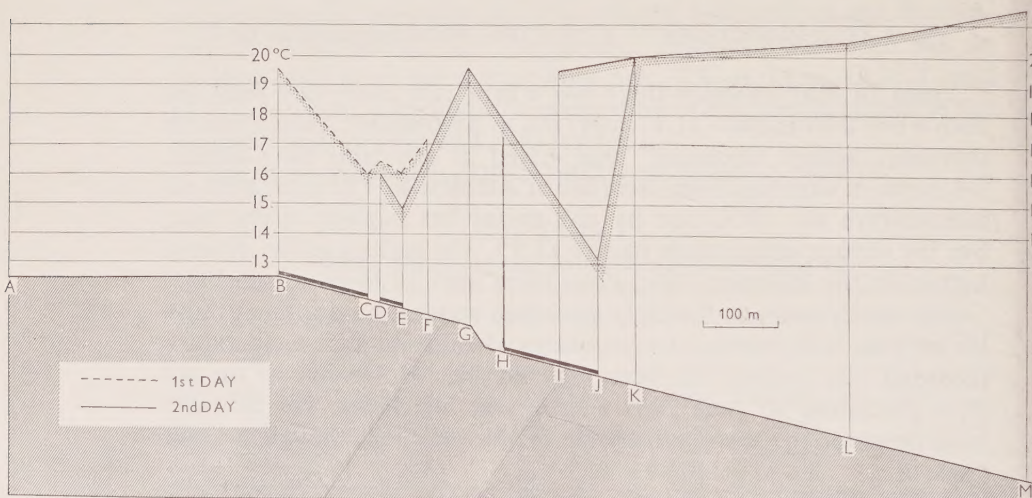


Fig. 5. Profile of Outgate Beck (A—J) and Ford Wood Beck (I—N), accurate horizontally but schematic vertically, showing temperature at different points during the afternoons of two consecutive days towards the end of a dry spell (24 and 25 July, 1955).

A—B cut through moss and rock; B—C first tunnel; D position of thermograph; D—E second tunnel; F point where lowest reading taken on first day; G top of falls; H—J third tunnel; I point in Ford Wood Beck above confluence; J point where Outgate Beck runs into Ford Wood Beck; K station 2; L bed of *Sparganium*; M station 1; N mouth

On the first, the water was cooled from 19.6°C to 16.0°C by the upper tunnel (B-C). On the second a temperature of 19.5°C at the top of the falls was reduced to 13.1°C by passage over the falls, which faced east, and through the lower tunnel (H-J).

That not only artificial tunnels cool the water was shown by observations made next day on a stream rising on open moorland, and later flowing down a fairly steep and wooded slope facing east. The day was sunny and the wind was blowing from the east, a dry quarter. Just above the wood the temperature of the stream was 21.6°C, a little higher than it had been further up. I walked through the wood beside the stream and took the temperature every five minutes. It was lower at every reading and reached a minimum of 14.0°C, that is it had lost 7.6°C in the shaded wood. ECKEL & REUTER (1950) point out that cooling is due to heat exchange between water and the soil and the air, and evaporation which depends on humidity and wind velocity. Cooling of a stream could also be due to the entry of cold groundwater. The drop in temperature under discussion is thought to be due largely to evaporation. Dr B. DOUGLAS has kindly put at my disposal the numerous observations that she has made on this stream (Belle Grange Beck). On wet days with a good flow, the temperature of the beck varies little from top to bottom; on sunny days with slight flow she has found differences ranging up to 5.3°C between the open part of the beck at the top and the shaded part near the lower margin of the wood.

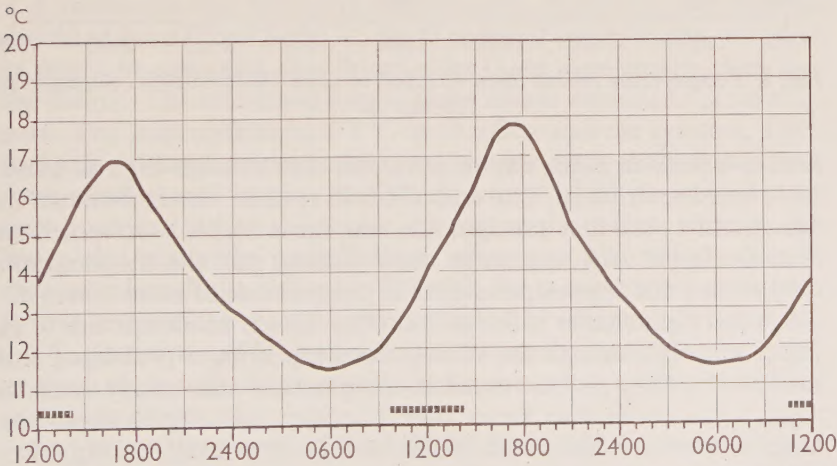


Fig. 6. Temperature record from noon 16 May to noon 18 May 1952. Horizontal bars show hours of sunlight, symmetrically about noon in the absence of record of when the sun did shine.

(c) Diurnal course of the temperature

Fig. 6 shows the course of the temperature on two days in May 1952. It was always like this in fine weather, though the range was less at other times of year. The noteworthy feature is the lateness of the times of maximum and minimum. Even in March the maximum was rarely attained before 4 p.m. The cut through the moss runs about SW by W and the sun does not, therefore, shine right into it till nearly 4 p.m., which may account for the lateness of the time of highest and lowest temperature. SCHMITZ (1954) found that the maximum in his stream was at about 2 p.m. at the source, progressively later at each station downstream, and about 6 p.m. at the mouth 4.47 km away. In overcast weather the record frequently ran for 24 hours or longer with scarcely any perceptible change in temperature. Under certain conditions, the diurnal changes can be quite irregular and figs. 7, 8 and 9 show some examples. The temperature in fig. 7

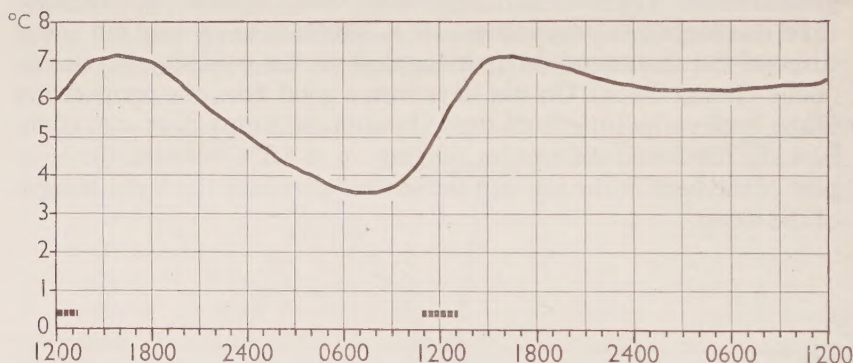


Fig. 7. Temperature record noon 10 April to noon 12 April 1951. Sunlight as in fig. 6.

rises to a peak on a fine day in April and then remains high as warm rainy weather drifts in. The end of a cold spell in winter is shown in figs. 8 and 1; the first precipitation was snow which later turned to rain. During a thaw, islands of snow floating past the thermograph may cause a sudden temporary fall in temperature of more than 1°C . Conversely in summer thunder rain often causes an abrupt rise of as much as 1.5°C , though the subsequent drop is more prolonged and rarely complete; on one occasion temperature was nearly back to what it had been two hours after a sudden rise. Fig. 9 shows the effect of a sudden burst of sunshine on a June morning during a wet spell.

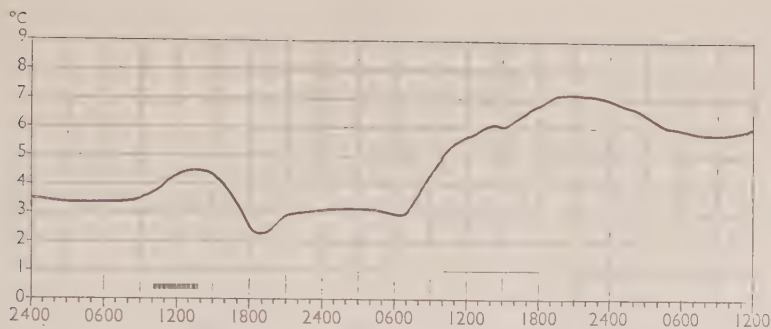


Fig. 8. Temperature record 21 to noon 23 March 1951.

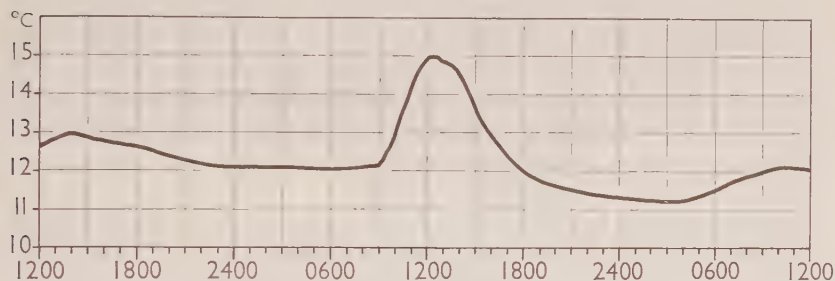


Fig. 9. Temperature record from noon 9 to noon 11 June 1954.

(d) Comparison with other stations

A maximum and minimum thermometer, kept for a year near the mouth of Ford Wood Beck (M, fig. 5) and read once a month, revealed, as might be expected, that fluctuations there were greater than near the source. The maximum temperature always exceeded that at Outgate. The least difference, 0.1°C in October, and the greatest, 2.9°C in April, occurred respectively at the seasons when daily fluctuations were smallest and largest. A difference over 2.0°C was recorded on four occasions out of the twelve. Except in the coldest weather, the water also generally cooled down more near the mouth than at Outgate, though the difference between the minima was not as great as that between the maxima, exceeding 2.0°C only once, when it was 2.4°C . SCHMITZ (1954) also notes that the increasing temperature range along the length of a stream is due more to a higher maximum than to a lower minimum.

Just below the source of Ford Wood Beck, which emerges from a long underground channel, single readings in the morning showed that fluctuations were less than at Outgate, the temperature being higher in winter and lower in summer. Usually the difference was

about 1°C but as much as 3° as noted after nights when there had been a big drop in air temperature.

The temperature of the other tributary, Sykeside Beck, was very similar to that at Outgate.

There is one other stream, Whelpside Ghyll, from which there are records worth commenting on. It is only slightly longer than Ford Wood Beck and does not carry a great deal more water, but it differs in that it rises at an altitude of 2800 feet (800 m) and falls very steeply, its average gradient being about 1 in 2½. At 2000 feet (600 m) another stream, mainly fed from seepages, joins it. The temperature of the spring, measured in five summer months in various years, ranged from 4.4°C in May 1951 to 4.9°C in August 1952, and evidently varies little in summer and probably not much through the year. The water warms rapidly after coming to the surface; on 25 August 1952 the temperature was 4.9°C at the source, 9.2°C at 2000 feet and 12.5°C at 600 feet at the bottom, this last reading having been taken first. It is not possible to say how much bigger differences simultaneous readings would have shown; in Outgate Beck the temperature ranged from 14.4 to 15.5°C during the same day.

The highest reading on a maximum and minimum thermometer hidden in the beck at 2000 feet in three summers was 15.0°C in 1952 sometime between 17 April and 25 August. Outgate reached a maximum of 19°C, 4°C higher, during the same period. The maximum in both 1951 and 1953 was 13.9°C, which was 2.8°C below that of Outgate Beck in 1951. Differences between spot readings and those on the thermograph at the same time are similar.

(e) Comparison of two years

The period of observation covered the exceptionally wet and sunless summer of 1954 and the exceptionally fine one of 1955. Actually the latter, though remembered because there was a good deal of sunshine and not much rain in July and August, was cold up to about mid-June and it was not until the end of June that the temperature rose above that of 1954. After this it remained higher for the next seventeen weeks. During this period the total number of degree hours was 35674 in 1954 and 40072 in 1955, which is not a very large difference; if the totals from late April, when the observations started in 1954, be taken, a given number of degree hours is reached a fortnight earlier in the warmer summer. But it may not be the number of degree hours above 0°C that is important; for example, two species of *Dytiscus* start growing one at 5°C the other at 10°C (BLUNCK, 1924) and accordingly some calculations from higher baselines are given in table II. Only twelve weeks are compared and this period has been

TABLE II

Temperature differences in twelve weeks starting 21 June 1954 and 20 June 1955.

Degree hours using as a baseline: -

	0	5	10	11	12	13	14	15°C
1955	29,859	19,769	9689	7678	5720	3885	2282	1035
1954	26,311	16,221	6143	4138	2259	855	185	19

chosen because it was the hottest time of year, the temperature being above 10°C throughout except for 3 hours in 1954, and the one when differences between the two years were greatest.

Many of the stream animals grow in winter and accordingly the warm winter of 1956/57 and the cold winter of 1954/55 have been contrasted. A period from the beginning of October to the end of May, being one during which *Rhithrogena semicolorata* can complete its development, has been taken. There were many more hours below 4°C in the colder than in the warmer winter (table III). What, from

TABLE III

Number of hours at various temperatures in 34 weeks from 4 October 1954 and 1 October 1956. Number of hours at say 3.5 C is in fact number of hours between 3.0 C and 3.9 C.

	0.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5	12.5	13.5	14.5	15.5
54/55	137	353	520	383	474	591	658	791	500	479	411	276	114	23		
56/57		12	75	182	556	957	659	985	954	449	476	290	17	24	12	2

the biological point of view, is probably a more important comparison of the same data is presented in table IV. The number of degree hours has been calculated for each week and added together so that the total reached after any given number of weeks is known. For the table

TABLE IV

Week in which approximately the same number of degree hours were attained in the winters 1954 55 and 1956 57 (starting on 4 October 1954 and 1 October 1956)

Total degree hours			Degree hours above 5°C		
sum of degree hours	week 54/55	week 56/57	sum of degree hours	week 54/55	week 56/57
18,700	14	14	7,000	14	13
21,300	18	17	7,165	24	14
22,400	21	18	7,600	27	18
24,300	25	20	8,000	28	23
30,500	30	26	12,200	34	31

have been chosen arbitrary totals approximately the same as totals actually reached in the two years, and the weeks when they were reached are shown. For the first 14 weeks, that is up to the end of the year, totals were similar with now one year, now the other, slightly in the lead. The next 12 weeks were cold in 1955, mild in 1957, and the number of degree hours reached in 20 weeks in the latter was only reached after 25 weeks in the former. During the remaining 8 weeks the two years were similar and the higher weekly totals reduced this lead and, at the end, the warmer year was between 3 and 4 weeks ahead of the colder. If the same calculation is made for temperatures over 5°C, the lead established by the warmer year reaches 10 weeks during the cold spell of the colder year when there was no reading at all during many weeks. However the totals in the cold period are so small that they do not greatly affect the final result which is much the same as that obtained when total degree hours were considered.

f. Comparison of water and air temperature

Maximum and minimum air temperature is recorded daily at Ambleside about 4 km from Outgate and these figures have been used to calculate a weekly average air temperature (fig. 10). In winter the air temperature may fall well below that of the water. In spring and early summer it is generally a degree or two higher, in late autumn the same amount lower. In the wet summer of 1954 the difference between the two was slight but in the fine July and August of 1955 air temperature was 2-3° above that of the beck. However, during this kind of weather, the cooling effect of the tunnel was most pronounced

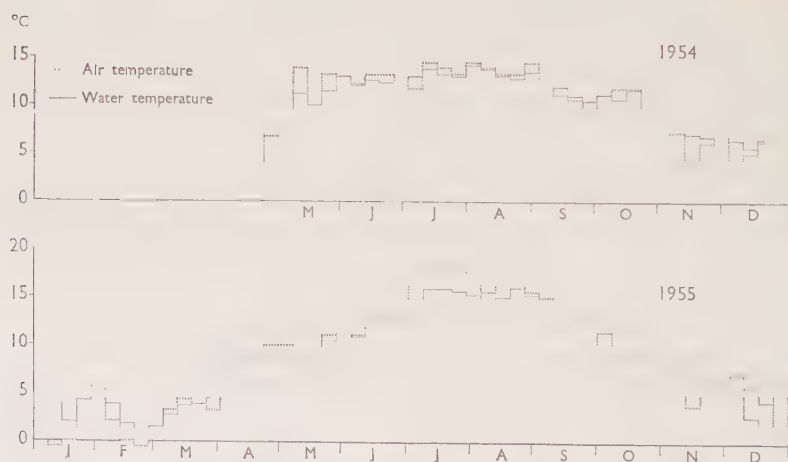


Fig. 10. Weekly average air temperature at Ambleside (daily maximum and minimum for 7 days \div 14) and weekly average stream temperature.

and the average temperature lower down the stream may well have been not far off that of the air. It probably reached this value also before it left the cut through the moss in which it originates.

SCHMITZ (1954) investigated a stream which originated from a pond in which the temperature ranged during the day of observation from 9.4 to 10.6°C. The water attained a maximum of 13.25°C 3.16 km from the source and did not get warmer in the remaining 1.3 km of its course. The figures agree well with those arrived at from a theoretical calculation using the formula of ECKEL & REUTER (1950). It seems that small streams warm up and reach a point of equilibrium in quite short distances from their sources and that their average temperature is not greatly different from that of the air. FRY & WATT (1955) find a satisfactory correspondence between air and lake temperature. GORHAM (1958) shows that the smallest Scottish lakes reach their maximum temperature in June whereas the largest are not at their warmest till September.

RESULTS OBTAINABLE WITH A SIMPLE THERMOMETER

A thermograph cannot be erected anywhere, because, for one thing, it is rather large and must be protected from the inquisitive. Accordingly I have examined the present records to discover how much of the information which they show could have been obtained with an ordinary thermometer.

Spot readings intended to give comparative data for a series of becks can obviously be highly misleading, for the temperature changes considerably over a short time (fig. 6) and according to a pattern that differs in different parts of the stream (SCHMITZ, 1954). This, however, is true only on sunny days particularly during the spring and early summer. Under other conditions a reliable comparison should be available.

If it is desired to make regular observations at one spot, a maximum and minimum thermometer, which is not expensive, can easily be buried in the bed of a stream. What information would it yield? Ideally it should be set twice a day, at about 8 o'clock in the morning and again at 6 o'clock in the evening, but this might prove difficult and the analysis that follows is based on the premise that only one setting a day would be possible. About 1 p.m. would be a good time since the temperature is generally midway between maximum and minimum then, and I have selected this hour, using it throughout the year and ignoring sun time, since this is a practical exercise. The maximum and minimum that a thermometer would have shown have been read off the thermograph chart, added together, and divided by two to

give what may conveniently be called the thermometer average. Sometimes seven consecutive maxima and minima have been added together and divided by 14 to give a weekly average, and on occasion for comparative purposes this has been multiplied by 168, the number of hours in a week, to give degree hours. What may be called the thermograph average has been obtained by counting on the chart the number of hours when the temperature was for example between 8 and 9°C, 9 and 10 C, 10 and 11°C and so on and multiplying them by 8.5, 9.5, 10.5 and so on. The sum of these products gives degree hours for the week, which divided by 168 gives the thermograph average. The method of finding degree hours is inaccurate if the temperature remains for a long period at such a temperature as for example 9.8°C, but in general error from this source is small.

The first calculation made was of the difference between thermometer and thermograph average on a number of days such as those illustrated in figs 7, 8 and 9, and discussed earlier, when the course of the temperature ran irregularly. It was found to be as much as 1°C on some days.

However, these are exceptional and it is more profitable to compare weeks, which has been done for 1955. A glance at fig. 6 reveals that the troughs are flatter than the peaks, from which it may be deduced that the thermometer average will be higher than the thermograph average. This proves to be the case. In only three of the 25 weeks from 11 April to early October was the thermometer average the lower. In 4 consecutive weeks from 25 April the difference ranged from 73 to 83 degree hours, the latter figure being 5% of the total. The actual averages differed by 0.5°C. Generally, however, the difference was less than this and the total degree hours for the 25 weeks was 53078 and 52336, that is the calculation from the thermometer average yielded 742 more than were actually found with the thermograph. This is only 1.4% of the total and negligible for practical purposes.

In the remaining 27 weeks of the year, the thermometer average was the higher 13 times and the two were identical once.

Figures were similar in 1954.

The maximum and minimum thermometer, then, gives a reasonably satisfactory average temperature and, since big fluctuations from the mean occur only in fine weather when the pattern is regular, some idea of degree hours above any given temperature can be obtained with it.

It is logical to enquire what sort of result would have been obtained if the observer had been able to read and set the thermometer once a week only. As might be expected, the weekly average based on one maximum and minimum tends to be higher during a period of warming and lower during a period of cooling, when compared with

averages based on 7 maxima and minima and with the thermograph average. It was the highest of the three in 9 out of the twelve weeks starting on 25 April and lowest in all the eleven weeks starting on 3 October. The weeks showing the biggest discrepancies are shown in table V. However over a long period the averages do not differ greatly. For example, during the twenty-five week period already discussed the total number of degree hours obtained from the thermometer average was 53078 on a daily and 53104 on a weekly reading, a difference of 26.

TABLE V

Differences between the weekly average calculated in three different ways.
Weeks showing the greatest discrepancies in 1955.

Week beginning	Average based on 7 max. and 7 min.	Average based on 1 max. and 1 min.	Average from thermograph
13 June	11.8	13.0	11.8°C
21 Nov	7.1	6.2	7.8°C

Evidently then in this beck had it been possible to read a maximum and minimum thermometer only once a week, general conclusions about the temperature would have been permissible provided that the period covered was not too short.

SCHMITZ (1954) describes three methods of measuring average temperature, all, however, involving fairly complicated apparatus.

ACKNOWLEDGMENTS

I have had valuable discussions with Messrs H. C. GILSON, E. D. LE CREN and F. J. H. MACKERETH and Drs E. GORHAM and J. H. MUNDIE, all of whom have been kind enough to read and comment on the manuscript. I also wish to thank my assistants, Mrs JEAN C. MACKERETH and Mr T. GLEDHILL who drew the diagrams. Further I take the opportunity to acknowledge my indebtedness to Dr G. PLESKOT who corrected the German summary.

SUMMARY

1. Records were obtained with a thermograph over a period of five years in a small stream.

2. Temperature fluctuated from 0°C to above 6°C in January and February; rose during the period from just before the equinox to

just after the equinox with daily fluctuations up to about 6°C; remained steady at a high level in July and August and then dropped steadily. Large daily fluctuations were rare in the second half of the year. The highest temperature was 19.0°C.

3. The highest temperatures were reached when the sun shone strongly after rain, not in dry spells when the water level was low.

4. Temperature fell in a man-made underground channel. In another stream it dropped from 21.6 C out in the open to 14.0°C in a wood facing east on a hot day when the wind was blowing from the east.

5. Temperature reached a minimum at about 6 a.m. and a maximum nearly 12 hours later.

6. Temperatures lower down the stream, fluctuated more; the difference between the maxima was greater than that between the minima.

7. From the present and from published observations it is concluded that small streams warm rapidly and reach equilibrium a few km from the source, the average water temperature being not greatly different from the average air temperature.

8. A given number of degree hours is reached in spring three to four weeks earlier after a warm winter than after a cold one.

9. Average weekly temperature obtained with a thermograph and with a maximum and minimum thermometer read once a day do not differ greatly. Even a weekly reading of the latter gives a fair picture over a long period.

ZUSAMMENFASSUNG

1. In einem kleinem Bach wurde der Temperaturgang fünf Jahre lang mit einem Thermographen gemessen.

2. Die Temperatur schwankte im Januar und Februar zwischen 0 C und ca. 6 C; von Mitte März bis Ende Juni stieg sie, mit täglichen Schwankungen bis zu 6°C; im Juli und August blieb sie hoch und danach fiel sie allmählich ab. In der zweiten Jahreshälfte waren grosse tägliche Schwankungen selten. Die höchste Temperatur war 19 C.

3. Das Wasser war nicht am wärmsten in Perioden ohne Niederschlag und mit niedrigen Wasserstand, sondern bei Sonnenschein nach Regen.

4. Die Temperatur erniedrigte sich deutlich bei Durchgang des Baches durch einen geschlossenen Kanal. Die Temperatur eines anderen Baches fiel an einem heissen Tag bei Ost-wind von 21.6°C in einer der Sonnenstrahlung ausgesetzten Strecke auf 14.0°C in einer Strecke die an einem ostexponierten Hang durch einen Wald führt.

5. Die Temperatur erreichte ihr Minimum um sechs Uhr früh, ihr Maximum ungefähr zwölf Stunden später.

6. Strömabwärts waren die täglichen Schwankungen grösser, wobei der Unterschied in den Maximalwerten grösser war als in den Minimalwerten.

7. Aus diesen Beobachtungen und denen anderer Autoren wird geschlossen, dass kleine Bäche sich rasch erwärmen und unterhalb der Quelle den Gleichgewichtszustand, bei dem sich der Mittelwert dem der Lufttemperatur nähert, erreichen.

8. Im Frühling wird eine bestimmte Wärmesumme nach einem kalten Winter drei bis vier Wochen später erreicht als nach einem warmen.

9. Die mit einem Thermographen oder mit einem täglich abgelesenen Maximum- Minimum thermometer gewonnene durchschnittliche Wochentemperatur ist ungefähr gleich. Wenn die Beobachtungsperiode nicht zu kurz ist, genügt auch eine Messung pro Woche.

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Contribution à la connaissance des Desmidiées du Sud-est de la Province de Québec et de la Gaspésie

par le

F. IRÉNÉE-MARIE, I.C., Dr. Sc,

Pointe-du-Lac, P. Q. Canada, 1956

Comme toutes les revues scientifiques sont débordées par les offres de matières intéressantes, nous renonçons à donner même un aperçu de notre voyage. Nous nous permettons tout au plus de fournir une liste des deux régions explorées. Nous y indiquons par un nombre chacun des lieux où nous avons fait nos récoltes. Cependant celle liste, avec les numéros, permet de localiser approximativement chacune de nos récoltes, et chacune des plantes que nous y avons trouvées. Qu'on nous pardonne de ne pouvoir faire davantage.

- | | |
|-----------------------------------|-----------------------------|
| 1. Lac Elegant | 14. Lac Ste-Marie |
| 2. Lac Raquette | 15. Laquet dans Ste-Paula |
| 3. Lac Caribou | 16. Lac Portage |
| 4. Lac Métivier | 17. Lac St-Moïse |
| 5. Laquet sans nom | 18. Rivière Jules Plourde |
| 6. Lac Sabot | 19. Lac Ste-Paula |
| 7. Lac de la Station | 20. Lac à la Truite |
| 8. Lac Famine | 21. Lac Pechedet |
| 9. Lac Frontière | 22. Lac Petite Madeleine |
| 10. Etang dans St-Adalbert | 23. Pointe à la Frégate |
| 11. Ruisseau dans St-Adalbert | 24. Lac Côté |
| 12. Lac à Pitoune | 25. Lac Floridorme |
| 13. Rivière Noire | 26. Lac Tit-Jean-Bon-Enfant |
| 27. Lac Vachon | 37. Lac Matapédia |
| 28. Lac St-Edmond | 38. Lac St-Modeste |
| 29. Laquet acide (Nord St-Edmond) | 39. Lac Laurent Peltier |
| | 40. Lac Ste-Anne |

- | | |
|----------------------------------------------|-----------------------------------------|
| 30. Lac de l'Aqueduc (Près
Chandler) | 41. Lac Boilard |
| 31. Laquet acide (Ouest
Chandler) | 42. Lac St-François |
| 32. Lac Crenn | 43. Ruisseau Noir |
| 33. Lac Joseph Vignet | 44. Lac Aylmer |
| 34. Lac St-Jules | 45. Laquet sans nom (Dans Is-
raéli) |
| 35. Lac sans nom (Vallée de la
Matapédia) | 46. Lac Noir |
| 38. Lac Aux Saumons | 47. Lac à la Truite |
| | 48. Lac William |
| | 49. Lac St-Joseph |

I

LES CLOSTERIUM DU SUD-EST DU QUEBEC

Le chiffre entre parenthèses indique le nombre de lacs où chaque espèce a été récoltée. Quand une espèce n'a été trouvée qu'en un ou deux lacs, nous en indiquons le numéro entre parenthèses.

Abréviations

- L. longueur,
l. largeur,
B. largeur des bouts à 5 mu de l'extrémité.
F.D. Flore Desmidiale (1939) par F. I.-M. I.C. Dr. Sc.
H. Hydrobiologia, Editeur P. VAN OYE, 30 St-Lievenslaan, Ghent, Belgique.
N.C. Le Naturaliste Canadien, Université Laval, Québec.
D. Die Desmidiaceen Europas, von KRIEGER (1937).
M. Monography of the British Desmidiaceae: W. et G. S. WEST (1904—1922).

1. *C. acerosum* (Schrank) Ehr. F.D., p. 71, figs 9, 11, pl. 6.
L.: 590—874 mu; l.: 35—80 mu; B.: 18—20 mu. (3).
2. Var. *minus* Hantzs, D, p. 319, fig. 7, pl. 34.
L.: 340 mu; l.: 20 mu; B.: 6 mu. (Lac No 24).
3. Var. *tumidum* Borge. D. p. 319, fig. 7, pl. 24.
L.: 340—470 mu; l.: 25—45 mu; B.: 6—10 mu. (Lacs 24 et 26).
4. *C. abruptum* W. et G. S. West, F.D, p. 78, figs 13 & 14, pl. 3.
L.: 130—165 mu; l.: 12—15.5 mu; B.: 5—6 mu. (4).
5. *C. aciculare* Toxon West, D, p. 265, figs. 1 & 2, pl. 12.
L.: 360—430 mu; l.: 4—7 mu; B.: 1.5—2 mu. (5).

6. *C. angustatum* Kutz, F.D. p. 60, figs. 9 & 10, pl. 2.
L.: 300—395 mu; l.: 17—18 mu; B.: 12—15 mu. (10).
7. *Var. clavatum* Hast. F.D. p. 60, fig. 11, pl. 2.
L.: 350—420 mu; l.: 22—24 mu; B.: 20—22 mu. (Lac No 3).
8. *C. Archerianum* Cleve, F.D. p. 58, fig. 4, pl. 7.
L.: 200—310 mu; l.: 19—23.5 mu; B.: 8—10 mu. (4).
9. *C. Baillyanum* Bréb. D. p. 327, figs 7 & 8, pl. 26.
L.: 590—600 mu; l.: 76—78 mu; B.: 25—28 mu. (6).
10. *C. Cornu* Ehr. D. p. 269, figs 5—9, pl. 15.
L.: 370—388 mu; l.: 10—15 mu; B.: 6—8 mu. (Lac No 6).
11. *C. costatum* Corda F.D. p. 64, figs. 3—5, pl. 1.
L.: 320—457, l.: 50—51 mu; B.: 14—16 mu. (12).
12. *Var. subcostatum* (Ndt.) Krieger. D. p. 360, fig. 6, pl. 34.
L.: 355—360 mu; l.: 58—59 mu; B.: 17 mu; environ 18 côtes (7).
13. *C. Dianae* Ehr. F.D. p. 66, figs 13—15, pl. 5.
L.: 200—315 mu; l.: 21.5—25 mu; B.: 4.5—6.5 mu. (5).
14. *Var. arcuatum* (Bréb.) Rabenh. F.D. p. 66, figs 1—3, pl. 4.
L.: 210—280 mu; l.: 18—24 mu; Courbure: 135°—146°. (Lacs Nos 11, 12).
15. *C. didymotocum* Corda F.D. p. 59, Emend. F.I.M. N.C, Vol. 71, 71, No 11, p. 283, et les figures qui accompagnent l'article.
L.: 340—389 mu; l.: 50—91 mu; B.: 20—26 mu. (16).
16. *Var. crassum* Gronb. D. p. 326, fig. 3, pl. 26.
L.: 460—470 mu; l.: 65—67 mu; B.: 23—23.5 mu; (Lacs Nos 6 et 28).
17. *Var. maximum* Gronb. D. p. 326, fig. 4, pl. 17.
L.: 480 mu; l.: 50 mu; B.: 19 mu. (Lac No 26).
18. *C. eboracense* (Ehr.) Turn. D. p. 282, fig. 4, pl. 17.
L.: 208—340; l.: 49—50 mu; B.: 10—16 mu. (7).
19. *C. Ehrenbergii* Men. F.D. p. 67, figs 3—6, pl. 5.
L.: 350—735 mu; l.: 72—149 mu; B.: 17—19 mu. (18).

20. *C. gracile* Bréb. F.D. p. 83, figs 15, 16, pl. 3.
Dimensions moyennes les plus communes:
L.: 168 mu; l.: 8 mu; B.: 6.5 mu. (13).
21. *Var. elongatum* W. et G. S. West. F.D. p. 84, fig. 12, pl. 7.
L.: 380—485 mu; l.: 4—6 mu; B.: 2—2.5 mu. (3).
22. *Var. intermedium* I. M. F.D. p. 84, figs 17—18, pl. 3.
L.: 210—243 mu; l.: 4.5—6 mu; B.: 3.5—4.5 mu. (Lacs 1 & 26).
23. *Var. tenue* (Lemm.) W. et G. S. West F.D. p. 83, figs 19 et 20, pl. 3.
L.: 68—100 mu; l.: 2.6—3 mu; B.: 1.5—2 mu. (3).
24. *C. idiosporum* W. et G. S. West F.D. p. 79, figs 4, 5, 9, pl. 3.
L.: 200—220 mu; l.: 9—10 mu; B.: 2—3.5 mu. (6).
25. *C. incurvum* Bréb. F.D. p. 69, figs 13 & 14, pl. 7.
W. KRIEGER le considère comme une variété de *C. Venus*: D, p. 273.
L.: 62—68 mu; l.: 11—12 mu; B.: 2.5 mu. (6).
26. *C. intermedium* Ralfs, F.D. p. 61, figs 6—8, pl. 1.
L.: 222—342 mu; l.: 19—23 mu; B.: 8—11 mu. (17).
27. *C. Jenneri* Ralfs, F.D. p. 68, figs 16—19 pl. 7.
L.: 110—120 mu; l.: 10—12 mu; B.: 7 mu (9).
28. *Var. robustum* W. et G. S. West, F.D. p. 67, fig. 10, pl. 4.
L.: 70—110 mu; l.: 13—16 mu; B.: 7—8 mu. (4).
29. *C. juncidium* Ralfs, F.D. p. 61, figs 21—22, pl. 3.
L.: 200—211 mu; l.: 6—7.5 mu; B.: 3—4 mu. (7).
30. *Var. elongatum* Roy et Biss. *forma recta*. f. nov.
L.: 385—390 mu; l.: 9—11 mu; B.: 8 mu (Lacs Nos 12 et 30).

Separata a typo forma recta cellulae.

31. *C. kutzingii* Bréb. F.D. p. 79, figs 15, 16, pl. 1.
L.: 300—485 mu; l.: 12—22 mu; B.: 2.5—3 mu. (12).
32. *Forma sygmoideum* I. M. F.D. p. 80, fig. 2, pl. 8.
L.: 280—475 mu; l.: 16—21 mu; B.: 3.5—4 mu. (Lac No 7).

33. *C. lanceolatum* Kutz. F.D. p. 72, figs 12—15, pl. 2.
L.: 274—290 mu; l.: 35—43 mu; B.: 10—12 mu. (7).
34. *Var. parvum* W. et G. S. West. D. p. 320, fig. 11, pl. 36.
L.: 160—207 mu; l.: 28—30 mu; B.: 12—14 mu. (5).
35. *C. Leibleinii* Kutz. F.D. p. 65, fig. 12, 13, pl. 4; ff. 6, 7, 8, 9, 16,
pl. 5.
L.: 133—142 mu; l.: 20—23.5 mu; B.: 10—10.5 mu. (21).
36. *C. Libellula* Focke, F.D. p. 81, fig. 12, pl. 3.
L.: 225—350 mu; l.: 35—51; B.: 13—15 mu. (9).
37. *Forma minus* Borge, Süßwasser-Chloroph. gesamm. (1894).
L.: 150—155 mu; l.: 26—28 mu; B.: 5—6.5 mu. (Lac No 21).
Première mention pour le Canada.
38. *Var. intermedium* Roy et Biss. F.D. p. 82, fig. 11, pl. 3.
L.: 110—140 mu; l.: 26—29 mu; B.: 10—12 mu. (Lacs Nos 16
et 21).
39. *C. lineatum* Ehr. F.D. p. 74, fig. 2, pl. 1.
L.: 430—750 mu; l.: 25—38 mu; B.: 6—8 mu; Stries: 18—20.
(18).
40. *Forma elongatum* K. Rosa. Studia Botanica Cechoslovaca, Vol.
12, p. 200.
L.: 600—710 mu; l.: 16—23 mu; B.: 5—7 mu. (Lac No 47).
41. *C. littorale* Gay. F.D. p. 74, figs 21—23, pl. 1.
L.: 155—225 mu; l.: 18—23 mu; B.: 3.5—5.5 mu. (3).
42. *C. Lunula* (Nitzsch) Ralfs. F.D. p. 70, figs 14—16, pl. 4.
L.: 510—600 mu; l.: 76—115 mu; B.: 20—22 mu. (18).
43. *Var. biconvexum* Schm. F.D. p. 71, fig. 10, pl. 6.
L.: 520—550 mu; l.: 80—90 mu; B.: 18—26 mu. (4).
44. *Var. coloratum* Klebs. B.D. Vol. 1. p. 152, fig. 2, pl. 18.
L.: 440—650 mu; l.: 67—102 mu. B.: 17—22 mu. (Lacs Nos 12
& 20).
45. *Var. intermedium* Gutw. D.: p. 303. Fig. 21, pl. 3.
L.: 430—550 mu; l.: 85—96 mu; B.: 16—18 mu. (Lacs Nos 24
& 28).

46. *Var. Massartii* (Wildem) Krieg. D. p. 304, fig. 2, pl. 22.
L.: 485—529 mu; l.: 105—120 mu; B.: 20 mu. (Lacs Nos 1 & 24).
47. *Var. maximum* Borge D. p. 304, fig. 4, pl. 21.
L.: 600—749 mu; l.: 150—180 mu; B.: 25—30 mu. (Lacs Nos 24 & 26).
48. *C. macilentum* Bréb. F.D. p. 60, fig. 1, pl. 7.
L.: 340—345 mu; l.: 11.5—12 mu; B.: 9—10 mu. (4).
49. *Var. minus* W. et G. S. West. D. p. 304, fig. 5, pl. 21.
L.: 240 mu; l.: 40 mu; B.: 16 mu. (Lacs Nos 1 & 3).
50. *C. malinvernianiforme* Gronb. D. p. 282, figs 2, 3, pl. 17.
L.: 334—345 mu; l.: 66—69 mu; B.: 16—17 mu. (Lacs Nos 7 et 86).
51. *C. moniliferum* (Bary) Ehr. F.D. p. 66, figs 1, 2, pl. 5.
L.: 220—372 mu; l.: 43—65 mu; B.: 16—18 mu. (12).
52. *C. parvulum* Naegli. F.D. p. 68, figs 4—6, pl. 6.
L.: 110—160 mu; l.: 10—14.5 mu; B.: 2—2.5 mu. (10).
53. *Var. angustum* W. et G. S. West. F.D. p. 68, figs 7—9, pl. 4.
L.: 101—106 mu; l.: 7.5—8 mu; B.: 2.5 mu. (Lacs Nos 27 & 33).
54. *C. peracerosum* Gay. M. Vol. 1, p. 154, figs 9—11, pl. 19.
L.: 155—295 mu; l.: 10—16 mu; B.: très aigus. (Lacs No 47).
55. *C. porrectum* Ndt. D. p. 369, fig. 9, pl. 36.
L.: 260—275 mu; l.: 20—21.5 mu; B.: 4 mu. (Lacs Nos 38 & 47).
56. *C. praelongum* Bréb. F.D. p. 77, figs 7, 8, pl. 6.
L.: 520—850 mu; l.: 13.5—21 mu; B.: 10 mu. (Lac No 28).
57. *Forma brevior* W. et G. S. West. F.D. p. 77, figs 10 & 11, pl. 7.
L.: 200—315 mu; l.: 12—13.5 mu; B.: 7.5—8 mu. (3).
58. *C. Pritchardianum* Arch. F.D. p. 73, fig. 1, pl. 6.
L.: 540—560 mu; l.: 56—62 mu; B.: 7.5—9.5 mu. (5).
59. *C. Pseudodianae* Roy. F.D. p. 67, figs 10—13, pl. 5.
L.: 180—250 mu; l.: 12—14 mu; B.: 2.5—3.5 mu. (11).
60. *C. Ralfsii* Bréb. F.D. p. 75, fig. 1, pl. 2.
L.: 425—490 mu; l.: 50—65 mu; B.: 12—13 mu. (11).

61. *Var. hybridum* Rabenh. F.D. p. 76, figs 2, 3, pl. 2.
L.: 485—580 mu; l.: 42—50 mu; B.: 12—12.5 mu.
62. *C. regulare* Bréb. F.D. p. 64, fig. 28, pl. 3.
L.: 210—300 mu; l.: 25—35 mu; B.: 6.5—9.5 mu. (7).
63. *C. rostratum* Ehr. F.D. p. 74, figs 1—4, pl. 3.
L.: 300—360 mu; l.: 19—21 mu; B.: 3—4.5 mu. (3).
64. *C. setaceum* Ehr. F.D. p. 60, fig. 17, 19, 20, pl. 1.
L.: 300—420 mu; l.: 8—9.5 mu; B.: 1.5—2 mu. (9).
65. *Var. rectum* var. nov.
L.: 310—415 mu; l.: 8—10 mu; B.: 1.5—2.5 mu. (Lac No 16).
Variété dont l'axe est droit, et sans aucune courbure.

Varietas sine curvatione, cum axe recto.
66. *C. strigosum* Bréb. F.D. p. 82, figs 7 & 8, pl. 3.
L.: 325—335 mu; l.: 18.5—20 mu; B.: 4—5 mu. (3).
67. *C. striolatum* Ehr. F.D. p. 62, figs 23, 24, 27, pl. 3.
L.: 370—425 mu; l.: 30—40 mu; B.: 10—12 mu. (15).
68. *Var. Borgei* Krieg. D. p. 339, fig. 11, pl. 28.
L.: 450 mu; l.: 50 mu; B.: 19 mu. (Lac No 1).
Cette variété est nouvelle pour l'Amérique du Nord.
69. *Var. erectum* Klebs F.D. p. 63, figs 13 & 14, pl. 1.
L.: 350—368 mu; l.: 30—32 mu; B.: 9—10.5 mu. (3).
70. *Forma. recta* W. West. F.D. p. 63, fig. 15, pl. 7.
L.: 240—310 mu; l.: 25—30 mu; B.: 8—9 mu. (3).
71. *C. subtruncatum* W. et G. S. West. F.D. p. 62, figs 23, 24, 27, pl. 3.
L.: 170—270 mu; l.: 21—27.5 mu; B.: 21—22.5 mu. (8).
W. KRIEGER a fait de cette espèce une variété de *C. striolatum* Ehr. Peut-être a-t-il raison, mais il ne donne aucun motif acceptable pour ce transfert, et l'autorité des WEST vaut bien celle de KRIEGER.
72. *C. subturgidum* Ehr. var. *giganteum* Ndt. H. Vol. 1—2, p. 17, fig. 1, pl. 3.
L.: 890—952 mu; l.: 51—60 mu; B.: 20—21 mu; Sutures: 5—6. (Lac No 26).

73. *C. subulatum* (Kutz) Bréb. F.D. p. 78, figs 17 & 18, pl. 4.
L.: 120—160 mu; l.: 8—12 mu; B.: 2.5—3 mu. (3).
74. *Var. majus* Krieg. D.: p. 263, fig. 9, pl. 13.
L.: 250—261 mu; l.: 13—15 mu; B.: 4 mu. (Lacs Nos 18 & 21).
75. *C. Toxon*, W. West. F.D. p. 83, fig. 2, pl. 7.
L.: 225—315 mu; l.: 8.5—11 mu; B.: 5.5—8 mu. (Lacs No 1 et 16).
76. *C. turgidum* Ehr. F.D. p. 73, figs 7 & 8, pl. 7.
L.: 560—870 mu; l.: 50—56 mu; B.: 20—21 mu. (3).
77. *C. Ulna* Focke. F.D. p. 61, fig. 2, pl. 8.
L.: 320—438 mu; l.: 14—14.7 mu; B.: 7.5—8.5 mu. (4).
78. *C. venus* Kutz F.D. p. 70, figs 14—17, pl. 4.
L.: 55-80 mu; l.: 7,5—9.5 mu; B.: 1—1.5 mu. (22).

Ce genre est l'un des mieux représentés dans la G a s p é s i e et l'Est du Q u é b e c. Nous en avons trouvé 48 espèces, 25 variétés et 7 formes; 2 variétés sont nouvelles pour la Science, 2 variétés et une forme sont nouvelles pour l'A m é r i q u e d u N o r d, une espèce, 5 variétés et 2 formes sont nouvelles pour le C a n a d a et 2 espèces, 5 variétés et 3 formes sont nouvelles pour la P r o v i n c e d e Q u é b e c.

II

LES DESMIDIEES DE LA GASPESIE

1956—1957

PENIUM Bréb.

Le groupe des *Penium* est représenté dans la région par 5 espèces et une variété.

1. *P. crassum* (West) I. M. N.C. Vol. 79, No 1, p. 21, étude.
L.: 59—68 mu; l.: 20—21 mu; B.: 12.5—15.5 mu. (Lac No 16).
Seconde mention pour le Canada.

2. *P. cylindrus* (Ehr.) Bréb. M. Vol. 1, p. 86, figs 1—5, pl. VI.
L.: 30—45 mu; l.: 10,5—13 mu. (Lac No 16).

Première mention pour le Québec. G. H. WAILES l'a signalé pour la Colombie Canadienne (1932); E. WHELDEN, pour le Nord Canadien (1947) et E. O. HUGUES, pour les Provinces Maritimes (1947—48).

3. *P. margartiaceum* (Ehr.) Bréb. F.D. p. 87, fig. 14, pl. 8.
L.: 130—172 mu; l.: 21—24.5 mu; B.: 13—14.5 mu. (3).

4. *Var. elongatum* Klebs. D. p. 332, fig. 6, pl. 10.
L.: 245—360 mu; l.: 20—28 mu; B.: 15—23 mu. (Lacs Nos 16 & 26).

Cellule environ 2 fois plus longue que le type, mais de même largeur. La membrane est de même nature, séparée en 3 ou 4 sections et terminée par des bouts semi-cylindriques. Première mention pour le Québec. Fig. 1.

5. *P. phymatosporum* Ndt. D. p. 237, figs 14—17, pl. 11.
L.: 45 mu; l.: 20 mu; B.: semi-circulaires. (Lac No 10).

Petite cellule à peu près cylindrique, sans constriction médiane ou avec une légère constriction, et atténuée graduellement du milieu vers les bouts. La membrane est délicatement striée longitudinalement. Les chloroplastes ne contiennent qu'un seul pyrénoloïde. Première mention pour le Canada. Fig. 2.

6. *P. polymorphum* Perty. F.D. p. 88, fig. 9, pl. 14.
L.: 45—56 mu; l.: 21—23.5 mu; B.: 15.5 mu. (Lac No 21).
Cette espèce est commune dans toute la Province.

PLEUROTAENIUM Nag.

Nous avons trouvé de ce genre, 10 espèces, 7 variétés et une forme dans le Sud-est de la Province.

1. *P. constrictum* (Bailey) Lagerh. F.D. p. 101, fig. 12, pl. 4. (Lacs 1 & 12).
L.: 455—550 mu; l.: 42—43.5 mu; B.: 26—30 mu; Is.: 25.7—30 mu.
2. *P. coronatum* (Bréb.) Rabenh. F.D. p. 97, figs 1, 2, pl. 12.
L.: 480—600 mu; l.: 55—62.5 mu; Is.: 36—48 mu; B.: 34—42 mu. (16).
3. *P. Ehrenbergii* (Bréb.) De Bary F.D. p. 97, figs 5, 6, pl. 11.
L.: 350—570 mu; l.: 25.5—31 mu; B.: 15—28 mu; Is.: 23—29 mu. (24).
4. *Var. arcuatum* I.—M N.C. Vol. 74, p. 104.
C'est la forme décrite dans F.D. p. 98. Elle a été retrouvée plusieurs fois en divers lieux de la Province et en Europe. Elle mérite le rang de variété.
L.: 435—550 mu; l.: 31—36 mu; B.: 21—26 mu; Is.: 31—33.5 mu. (3).
5. *Var. elongatum* W. West. F.D. p. 98, figs. 8, 9, pl. 11.
L.: 570—600 mu; l.: 23.5—28 mu; B.: 20—23.5 mu; Is.: 19.5—24,6 mu. (Lac No 35).
6. *Var. granulatum* Ralfs. F.D. p. 98, fig. 7, pl. 8. (Lacs Nos 16 & 30).
L.: 450—455 mu; l.: 30—32 mu; B.: 25.5—26 mu; Is.: 24.5 mu.
7. *P. maximum* Lund F.D. p. 94, figs 3, 4, pl. 10.
L.: 560—858 mu; l.: 31—43 mu; B.: 22—31 mu. (3).
8. *P. minutum* (Ralfs) Delp. F.D. p. 95, figs 20, 21, pl. 9.
L.: 120—195 mu; l.: 10—15.5 mu; B.: 8—10 mu. (9).
9. *Var. elongatum* W. et G. S. West. F.D. p. 96, fig. 4, pl. 11.
L.: 310—330 mu; l.: 10.5—15 mu; B.: 8.5—9 mu. (4).
10. *Forma major* Lund. F.D. p. 96, figs 1—4, pl. 11. (Lac No 12).
L.: 175—240 mu; l.: 13—20.5 mu; B.: 14—15.6 mu. Is.: 15.2—17.5 mu.

11. *P. nodosum* (Bailey) Lund. F.D. p. 101, fig. 5, pl. 12. (Lacs Nos 3 & 12).
L.: 340—415 mu; l.: 46—51 mu; B.: 25.5—29 mu. Is.: 31—32 mu.
12. *P. nodulosum* (Bréb.) De Bary. F.D. p. 93, figs 1 & 2, pl. 10.
L.: 650—1200 mu; l.: 72—88 mu; B.: 44—48 mu; Is.: 55—68 mu. (3).
13. *P. subcoronulatum* (Bréb.) Rabenh. Alg. Aq. Dulc. Indiae Orient. p. 29, fig. 19, pl. 11.
L.: 485—550 mu; l.: 46—50 mu; B.: 35—44 mu. (Lac No 24).
Première mention du type pour le Canada. Sa variété *detum* est assez commune dans nos régions. Fig. 3.
14. *Var. detum* W. et G. S. West F.D. p. 97, fig. 3, pl. 12.
L.: 390—510 mu; l.: 32.5—33.5 mu; B.: 30—31.5 mu. (4).
15. *P. Trabecula* (Ehr.) Naegli F.D. p. 94, figs. 5 & 6, pl. 10.
L.: 500—650 mu; l.: 25—43 mu; B.: 20—24 mu; Is.: 24—31 mu. (23).
16. *Var. rectum* (Delp.) W. West. F.D. p. 95, figs. 10, 11, pl. 11.
L.: 240—350 mu; l.: 19—24.5 mu; B.: 12—14 mu; Is.: 14—15.5 mu. (3).
17. *Var. clavata* (Kutz.) W. et G. S. West F.D. p. 95, figs 7, 8, pl. 10.
L.: 350—410 mu; l.: 26—33 mu; B.: 27—32 mu. (7).
18. *P. truncatum* (Bréb.) Naegli. F.D. p. 102, figs 12 & 13, pl. 11.
L.: 540—575 mu; l.: 71—73.5 mu; B.: 33—75 mu; Is.: 62—66 mu. (8).

DOCIDIUM Bréb. (1844) emend. Lundell (1871).

Ce genre est mal représenté dans la G a s p é s i e. Nous n'en avons trouvé que les deux espèces suivantes, déjà signalées dans toute la Province:

1. *D. baculum* Bréb. F.D. p. 105, figs 9, 10, pl. 12.
225—265 mu; l.: 9.5—10 mu; B.: 6.5 mu. (Lacs Nos 35 & 43).
2. *D. undulatum* Bailey. F.D. p. 105, fig. 7, pl. 12. (3).
L.: 215—220 mu; l.: 16.5—18 mu; B.: 17—17.5 mu.

TRIPLOCERAS Bailey (1851).

De ce genre, nous n'avons trouvé que les deux espèces les plus communes dans la Province et dans deux stations seulement.

1. *T. gracilis* Bailey. F.D. p. 107, fig. 1, pl. 9. (Lacs Nos 12 & 26).
L.: 335—360 mu; l.: 28.5—31.5 mu; B.: 10—15 mu (sous le dern. verticille).
2. *T. verticillatum* Bailey. F.D. p. 108, figs 3, 4, pl. 9. (Lacs Nos 12 & 26.)
L.: 465—580 mu; l.: 40—52 mu; B.: 24—31.5 mu (sous le dern. verticille).

TETMEMORUS Ralfs.

Nous n'avons trouvé qu'une seule espèce de ce genre en Gaspésie. Au nord du St-Laurent nous en avons récolté 5 espèces et 2 variétés. (Lacs 37 & 45).

1. *T. Brébissonii* (Men.) Ralfs. F.D. p. 111, fig. 15, pl. 11, fig. 8, pl. 67.
L.: 160—225 mu; l.: 30.5—45 mu; Is.: 22—32.5 mu. B.: 22—23 mu.

EUASTRUM Ehr.

Ce genre est représenté dans la Gaspésie et le Sud-Est du Québec par 45 entités réparties en 25 espèces, 17 variétés et 5 formes, alors que dans la Mauricie, nous en avons trouvé environ 60 entités différentes.

Abréviations: *lp*: largeur du lobe polaire; *Lp*: longueur du lobe polaire; *E*: épaisseur; *Ia*: profondeur de l'incision apicale; *ls*: largeur du sommet. *H.*: Hydrobiologia; *N.C.*: Naturaliste Canadien; *D.* Die Desmidiaceen.

1. *E. abruptum* Ndt. Freshwater Algae of South U.S.: Presc. & Scott p. 231, fig. 1, pl. 1. figuré aussi dans *H.* Vol. IV, No 1, fig. 7, pl. XIX.

L.: 37—40 mu; l.: 26.5—28.5 mu; Is.: 7.5—8.5 mu. (Lac No 3).

Cellule rectangulaire, hémisomate trapésoïdal 3-lobé: le lobe polaire court, au sommet tronqué, encoché largement et profondément, aux angles latéraux prolongés en épines obtuses, les marges du Lobe polaire convergeant pour former le côté de ce lobe; les sinus largement ouverts entre le lobe polaire et le milieu du lobe latéral, lequel

est légèrement bi-lobulé, le lobe latéral supérieur plus profondément creusé que l'inférieur, ces deux lobes séparés par une protubérance arrondie, et ornée de 8 petites épines.

Les sinus médians sont linéaires et fermés extérieurement par des mucrons. Le centre de chaque hémisomate est orné d'une rosace formée de 3 granules courbés.

La vue apicale est quadrangulaire, les deux lobules du sommet polaire sont séparés par une fente ordinairement bien ouverte, et terminés chacun par un mucron vers l'extérieur.

Cette espèce a été signalée par G. W. PRESCOTT dans les *E t a t s* du *S u d* dès 1945. Ceci est sa première mention pour le Canada.

2. *Forma minus* W. et G. S. West. F.D. p. 130, fig. 15, pl. 18; fig. 3, pl. 19.

L.: 23—25 mu; l.: 18—20 mu; Is.: 4.5—5.5 mu; Lp: 14—16 mu; Is.: 3 mu. (Lacs Nos 1 & 6).

3. *E. affine* Ralfs. F.D. p. 121, fig. 4, pl. 15; fig. 9, pl. 16 (Lacs Nos 6—12).

L.: 85—90 mu; l.: 54—60 mu; Is.: 18—20 mu; lp: 25—30 mu.

4. *E. ampullaceum* Hass. F.D. p. 123, fig. 1, pl. 16, (3).

L.: 90—100 mu; l.: 55.5—57 mu; Is.: 13.5—15 mu; lp.: 23—25 mu; Ia.: 9—10 mu.

5. *Forma latum* I.—M. H. Vol. 1, p. 162, fig. 12, pl. 18. (Lac No 12).

L.: 100 mu; l.: 60 mu; Is.: 20 mu; lp.: 30 mu.

6. *E. ansatum* Ralfs. F.D. p. 126, fig. 10, pl. 16. (7).

L.: 84—123 mu; l.: 40—51 mu; Is.: 13—20 mu; lp.: 17—23 mu, Ia.: 5—6 mu.

7. *E. binale* (Turp.) Ehr. F.D. p. 138, fig. 4, pl. 19. (5).

L.: 19.3—20 mu; l.: 13.7—15 mu; Is.: 3.5—3.8 mu; lp.: 10—12 mu.

8. *Forma hians* W. West. F.D. p. 139, figs 1, 2, pl. 18. (5).

L.: 12—17 mu; l.: 11—13 mu; Is.: 3—3.5 mu.

9. *E. cornubiense* W. et G. S. West. N.C. Vol. 76, No 11, p. 280 fig. 3, pl. 3.

L.: 32 mu; l.: 22—23 mu; Is.: 8 mu; lp.: 13—14 mu. (Lac No 29).

Nous avons signalé cette espèce pour le lac Mistassini en 1949. Elle n'a pas encore été retrouvée ailleurs qu'au Canada. W.

R. TAYLOR en découvrit et en figura une forme pour notre province de Terre neuve (1935). Cette petite espèce est aussi rare en Europe qu'en Amérique.

10. *E. crassum* (Bréb.) Kutz. var. *michiganense* Presc. Notes on Michi. Desm. Papers of the Mich. Acad. Sc. Arts and Lett. Vol. XX, p. 165, ff, 1 & 2, pl. 26.
L.: 176 mu; l.: 75 mu; Is.: 35 mu; lp: 50 mu; Memb. gran. (Lac No 12).

11. *E. denticulatum* (Kirchn.) Gay. N.C. Vol. 78, No 7, p. 200, fig. 5, pl. IV.
L.: 20—20.5 mu; l.: 20 mu; Is.: 5 mu; lp.: 12 mu. (Lac No 16).
Cette petite espèce assez commune aux Etats-Unis apparaît dans le Québec pour la 2^e fois.

12. Var. *quadrifarium* Krieg.: D.: p. 585, figs 20 & 21, pl. 80.
L.: 24—29 mu; l.: 15.5—22 m ; Is.: 5—6 mu. (Lac No 3).
Hémisomate formé de deux lobes rectangulaires: celui de la base et celui du sommet, séparés par des sinus peu profonds. Le lobe polaire est divisé en deux par une coche atteignant le tiers de la largeur du lobe supérieur, et se termine aux angles par des mucrons aigus. Le centre du lobe de la base porte une protubérance formée de 4 granules; la membrane s'orne de granules épars au centre. La vue apicale est elliptique, dentelée par les granules de la surface, et montre le lobe polaire divisé en deux parties par une fente rectiligne et se terminant en pointe extérieurement.

Ceci est la première mention de la variété de KRIEGER depuis sa description en 1932. Fig. 4.

13. *E. Didelta* (Turp.) Ralfs. F.D. p. 123, figs. 5, 6, pl. 16 (7).
L.: 92—97 mu; l.: 48—50 m ; lp.: 20—22 mu; Is.: 18 mu.
14. Var. *ansatifforme* Schm. F.D. p. 124, fig. 4, pl. 16.
L.: 100—125 mu; l.: 46—55 mu; lp. 20—22.5 mu. (Lacs Nos 5 et 16).
15. *E. divaricatum* Lundell. F.D. p. 131, figs 5, 6, pl. 17. (Lac No 45).
L.: 43—45 mu; l.: 31—38 mu; Is.: 7—8 mu; lp.: 15—18 mu; E.: 20—22.5 mu.

La protubérance centrale est formée de 3 granules allongés verticaux.

16. *E. dubium* Nag. var. *latum* Krieger D.: p. 572, figs 7—9, pl. 79.
L.: 31—45 mu; l.: 24—32 mu; Is.: 5—7 mu. (3).

Cellule relativement plus large que le type, la longueur et la largeur dans le rapport de 5 à 4. Les mucrons des sommets sont présents ou non. Les ondulations des marges latérales sont moins prononcées. La vue apicale est à peu près typique; le centre de l'hémisomate, sans ornementation. Fig. 5.

17. *E. elegans* (Bréb.) Kutz. F.D. p. 128, figs 6, 7, pl. 18; fig. 5 pl. 20.
L.: 29—32 mu; l.: 19.3—21 mu; Is.: 6.4 mu; lp.: 12.8—13.5 mu; (17).

18. *Var. bidentatum* Nag. F.D. p. 128, fig. 10, pl. 18; fig. 3, pl. 20.
L.: 45—48 mu; l.: 25.5—30 mu; Is.: 8.3—12 mu; lp.: 19 mu (sin. spin.) (Lacs Nos 21 & 30).

KRIEGER, dans son ouvrage *Die Desm.* pp. 590 et suivantes ne semble pas reconnaître la variété de NÄGLI. Nombreux cependant sont les auteurs qui considèrent comme valide cette variété, à commencer par les WEST, dans leur volume IIp. 41 de Mon. of „The Brit. Desm.” Il convient toutefois de ne pas confondre *E. bidentatum* Nag. avec la variété *bidentatum* de l'espèce *E. elegans*.

19. *E. evolutum* W. et G. S. West F.D. p. 133, fig. 18, pl. 66. (Lacs Nos 8 & 16).
L.: 58—65 mu; l.: 38—45 mu; Is.: 12—14.5 mu; lp.: 31—32.5 mu; Is.: 5 mu.

20. *Var. Glaziovii*. W et G. S. West F.D. p. 134, fig. 1, pl. 19. (Lacs Nos 7, 12).
L.: 54—63 mu; l.: 34—39 mu; Is.: 7—8 mu; lp. 33—36 mu. Ia.: 7—8 mu.

21. *Var. integrius* (Ndt.) W. et G. S. West. F.D. p. 134, fig. 8, pl. 19. (4).
L.: 40—52 mu; l.: 30—32 mu; Is.: 9—10 mu; lp.: 20—24 mu

22. *E. gemmatum* Bréb. F.D. p. 135, fig. 3, pl. 17. (5).
L.: 48—57 mu; l.: 37—43 mu; Is.: 12—14 mu; lp.: 23—25 mu.

23. *E. insigne* Hass. N.C. Vol. 74, No 3, p. 116, fig. 11, pl. 1.
L.: 95—115 mu; l.: 51—53 mu; Is.: 10—12 mu; lp.: 25—26.5 mu. (3).

24. *Var. lobulatum* Presc. & Scott. N.C. Vol. 74, No 3, p. 117, fig. 10, pl. 1.
L.: 85—100 mu; l.: 53—55 mu; Is.: 4—5.5 mu; lp.: 25—30 mu. (3).

25. *E. insulare* (Wittr.) Roy. F.D. p. 140, fig. 12, pl. 8; figs 3, 5, pl. 18; Figs. 5, pl. 19. (4).
L.: 21—29 mu; l.: 16—21.5 mu; Is.: 3.5 mu; Lp.: 10—13 mu.
26. *E. montanum* W. et G. S. West. N.C. Vol. 76, No 11, p. 283, fig. 24, pl. 3.
L.: 15—25 mu; l.: 13—18 mu; Is.: 3.3—4 mu; ls.: 9—11 mu.
(Lac No 25).
27. *E. obesum* Josh. F.D. p. 125, fig. 9, pl. 8. (4).
L.: 55—100 mu; l.: 32—50 mu; Is.: 10—18.5 mu; lp.: 16—24 mu
La plante décrite sous le nom de *E. obesum forma*, dans F.D. p. 125, semble bien être le type de l'espèce, si l'on s'en rapporte au dessin de JOSHUA dans Burmese Desmids: Journ. Linn. Soc. Bot. No XXI (1886).
Dans le lac No 1, nous avons trouvé une forme se rapprochant beaucoup de *E. obesum* Josh. forma *subangulare* W. et G. S. West.
28. *E. oblongum* (Grev.) Ralfs. F.D. p. 120, figs 1, 2, 3, pl. 14. (11).
L.: 145—200 mu; l.: 75—110 mu; Is.: 21—30 mu; lp.: 56—62 mu.
29. *Var. cephalophorum* W. West. M.: Vol. 2, p. 14, fig. 1, pl. 35.
L.: 160—168 mu; l.: 81—89 mu; Is.: 27—28 mu; lp. 26—28 mu. (3).
Cette variété a été trouvée déjà par J. A. CUSHMAN à Terre-Neuve (1907). Ceci semble bien être sa première mention pour le Québec.
30. *Forma elliptica* I.—M. N.C. Vol. 74, No 3, p. 120, fig. 5, pl. II.
L.: 140—151 mu; l.: 60.5—83 mu; Is.: 17—20 mu. (3).
31. *E. pectinatum* Bréb. M.: Vol. 2, p. 60, figs. 10—12, pl. 39. (Lac No 7.)
L.: 70 mu; l.: 47 mu; Is.: 18 mu. lp.: 25 mu. Fig. 7.
Cette espèce a été trouvée déjà par CEDERCREUTZ au L a b r a d o r (1943). Il l'a mentionnée sans la décrire. Ceci serait la 2e mention de l'espèce chez nous.
32. *Var. brachylobulum* Wittrock. F.D. p. 134, fig. 4, pl. 15.
L.: 73 mu; l.: 46 mu; Is.: 14 mu; lp.: 27 mu. (Lacs Nos 3 et 7).
33. *Var. involutum* W. et G. S. West. M.: Vol. II, p. 61, figs 13—15, pl. 39.
L.: 70 mu; l.: 47 mu; lp.: 25 mu; Is.: 18 mu. (Lac No 8) fig. 8.

Première mention de cette variété pour le Québec. W. R. TAYLOR en a trouvé une forme très proche à Terre-Neuve vers 1935; et G. H. WAILES l'a trouvée en Colombie Canadienne (1923). J. A. CUSHMAN l'avait déjà signalée à Terre-Neuve dès 1906. Quant à la forme signalée par G. W. PRESCOTT pour l'Île Royale (Papers of the Mich. Ac. of Sc. Arts and Lett. Vol. XXII, p. 212, fig. 9), c'est une forme assez éloignée du type et de la variété des WEST.

34. *E. pingue* Elfv. N.C. Vol. 78, No 7, p. 204, fig. 8, pl. IV. (Lac No 12).

L.: 70—75 mu; l.: 44—48 mu; lp.: 20—24 mu; Is.: 12—13 mu.

C'est une plante très rare qui n'avait encore été trouvée en Canada qu'aux alentours de Québec (1951).

35. *E. pinnatum* Ralfs. F.D. p. 120, fig. 5, pl. 13 (3).

L.: 115—130 mu; l.: 60—64 mu; Is.: 17—20 mu; lp.: 30—33 mu.

36. *E. sinuosum* Lenorm. *Var. reductum* W. et G. S. West. F.D. p. 122, figs 5, 6. pl. 14; fig. 5, pl. 15. (Lacs Nos 1 et 12.)

L.: 45—51 mu; l.: 20—30 mu; Is.: 10—13 mu.

37. *E. sphyroides* Ndt. *var. intermedium* Lutkem. D.: p. 626, fig. 15, pl. 90.

L.: 36—45 mu; l.: 26—33 mu; Is.: 11—11.5 mu. (Lac No 48.)

Très petite variété qui ne se différencie du type que par ses rosaces centrales non granuleuses, mais ornées de petites épines comme sur les différents lobes, sur les marges de ces lobes et sur les angles des différents sommets, lesquels portent chacun trois granules aigus.

La vue apicale est elliptique, montrant sur chaque marge latérale une protubérance centrale de forme presque rectangulaire et lisse au centre. Cette variété est nouvelle pour le Canada. Le type auquel appartient cette variété n'a pas encore été trouvé chez nous ni dans l'Amérique du Nord.

38. *E. trigibberum* W. et G. S. West. N.C. Vol. 74, No 3, p. 121, fig. 3, pl. 2.

L.: 24—26 mu; l.: 20—20.5 mu; Is.: 6.5 mu; lp.: 14—15 mu.

Ceci est la deuxième mention de l'espèce pour la Province de Québec. Nous l'avons trouvée dans la région des Trois-Rivières en 1946, mais ce sont les deux seules mentions de l'espèce pour la Province.

39. *E. urnaforme* Wolle. F.D. p. 137, fig. 2, pl. 16.

L.: 70—75 mu; l.: 53—55 mu; Is.: 12—14 mu. (Lac No 12).

Depuis sa description vers 1892, cette espèce n'a été retrouvée que 5 fois et toujours dans l'Amérique du Nord. Elle est encore inconnue en Europe.

40. *E. verrucosum* Ehr. F.D. p. 136, figs 8 & 9, pl. 18. (7).
L.: 90—106 mu; l.: 76—80 mu; Is.: 17.5—19 mu; lp.: 30—59 mu
41. *Var. alatum* Wolle F.D. p. 136, fig. 2, pl. 17. (7).
L.: 86—95 mu; l.: 70—86 mu; Is.: 20—23 mu; lp.: 34—36 mu.
42. *Forma minus* Kossinsk. F.D. p. 137, fig. 2, pl. 17.
L.: 65 mu; l.: 60 mu; Is.: 20 mu; lp.: 30 mu; (Lac No 29).
43. *Var. apiculatum* Istvanf. J. Laporte: Recherches sur la Biol. et la Sys. des Desmidiées, p. 87, fig. j. p. 87. (Lacs Nos 7 et 16).
L.: 90—105 mu; l.: 86—102 mu; Is.: 13 mu. Les angles des lobes de la base portent 4 spinules aiguës. Le reste de la cellule a l'apparence de la variété *alatum* Wolle.
44. *Var. coarctatum* Delp. N.C. Vol. 74, No 3, p. 123, fig. 8, pl. 2.
L.: 64—72 mu; l.: 58—63 mu; Is.: 15.6 mu; lp. 28.5—29 mu. (3).
45. *Var. subalatum* Hub. Pest. D. p. 651, fig. 4, pl. 96. (Lac No 26).
L.: 87—99 mu; l.: 73—84 mu; Is.: 24—27.5 mu.

Variété qui se distingue du type par ses sinus médians fermés et par sa longueur comparativement plus considérable. Son isthme est plus large que chez la variété *alatum* Wolle. Première mention pour le Canada.

MICRASTERIAS Agardh.

Le genre *Micrasterias* semble moins bien représenté dans le Sud et l'Est que dans le Nord et le Nord-Ouest de notre Province. Cependant nous y avons récolté durant notre voyage de l'été dernier, 14 espèces, 6 variétés et une forme déjà connues, ainsi que plusieurs formes nouvelles ou anormales.

1. *M. americana* (Ehr.) Ralfs. F.D. p. 234, fig. 11, pl. 36. (4).
L.: 125—143 mu; l.: 105—142 mu; Is.: 26.5—28 mu; lp.: 55—75 mu.
2. *Forma gaspensis* f. nov. Fig. 13. (Lac No 38.)
L.: 120—131 mu; l.: 99—129 mu; Is.: 27—28.5 mu; lp.: 52—70 mu.

Forme qui se distingue du type par son lobe polaire beaucoup plus

massif, et par ses appendices apicaux plus courts; par l'absence de papilles au fond des sinus, à la base du lobe polaire, et par sa membrane plus lisse.

Forma separata a typo lobo polari multo solidiore et apicalibus appendicibus brevioribus: absentia papillarum plerumque presentium in apicem sinuum, in quoque latere lobarum polarium, et membrane laeviore.

3. *M. apiculata* (Ehr.) Men. F.D. p. 225, fig. 8, pl. 38, et fig. 1, pl. 41.

L.: 240—275 μ ; l.: 215—235 μ ; Is.: 36—45 μ ; lp.: 81—85 μ . (8).

Le lac No 6 présente en plus un très grand nombre de formes anormales. La fig. 14 est celle d'un beau spécimen où est absente la rosace qui occupe ordinairement le centre de la base de chaque hémisomate, et chez lequel les épines des sommets sont très développées. Fig. 14.

4. *M. Crux-melitensis* (Ehr.) Hass. A History of the Brit. Fresh-water Algae, Vol. 1, p. 386, fig. 7, pl. XC.

L.: 110—132 μ ; l.: 100—120 μ ; Is.: 16—18 μ ; lp.: 36—45 μ . (4).

La fig. 10 de F.D. pl. 36 ne nous semble pas représenter adéquatement l'espèce *Crux-melitensis*, si l'on s'en rapporte à l'ouvrage de HASSALL. C'est plutôt un intermédiaire entre les espèces *M. radiata* Hass. et *Crux-melitensis* Hass. L'espèce semble avoir été mieux comprise et mieux dessinée par les WESTS (Monog. Vol. II, Fig. 1—3, Pl. 53.)

5. *M. denticulata* Bréb. F.D. p. 228, fig. 1—4, pl. 39.

L.: 236—280 μ ; l.: 196—240 μ ; Is.: 26—36 μ ; lp. 50—53 μ . (6).

6. *M. depauperata* Ndt. Var. *Wollei* Cushman. F.D. p. 223, fig. 1, pl. 33; figs 5, 8, pl. 36. (Lac No 12).

L.: 136—155 μ ; l.: 128—143 μ ; Is.: 20—25 μ ; lp. 86—95 μ .

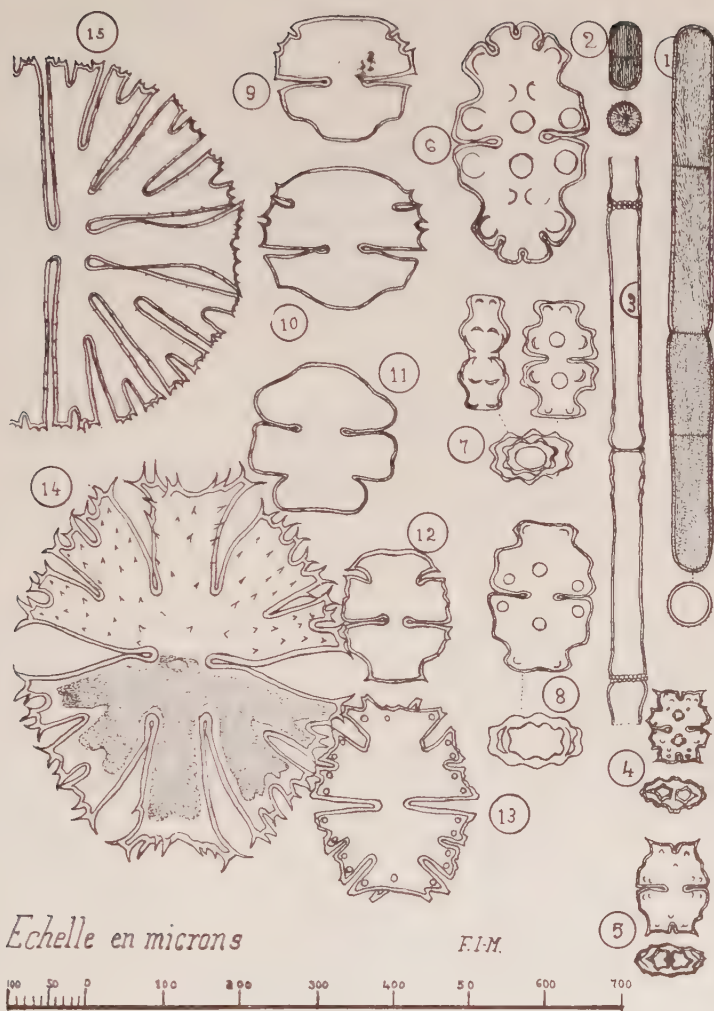
7. *M. laticeps* Ndt. F.D. p. 221, figs 2—5, pl. 35. (6).

L.: 130—156 μ ; l.: 130—189 μ ; Is.: 19—26 μ ; lp.: 125—160 μ .

8. *M. mahabuleshwarensis* Hob. var. *dichotoma* (G. M. Smith) Krieg. F.D. p. 231, fig. 2, pl. 40 de F.D. (Lacs Nos 21 et 31).

L.: 150—160 μ ; l.: 140—160 μ ; Is.: 18—21 μ ; lp.: 73—87 μ .

9. *M. muricata* (Bailey) Ralfs. F.D. p. 233, fig. 1, pl. 35; fig. 6, pl. 41
L.: 165—200 mu; l.: 115—135 mu; Is.: 22—23.5 mu; lp. 87—92
mu. (Lac No 12).
10. *M. papillifera* Bréb. F.D. p. 227, fig. 1, pl. 34; figs 2—6, pl. 37;
f. 6, pl. 38.
L.: 152—155 mu; l.: 135—143 mu; Is.: 16—22.5 mu; lp.: 34—
40 mu. (7).
11. *M. pinnatifida* (Ktz.) Ralfs. F.D. p. 219, figs 19, 20, pl. 33.
L.: 60—70 mu; l.: 68—79 mu; Is.: 11—13 mu; lp.: 44—57 mu.
(4).
12. *M. radiata* Hass. F.D. p. 231, fig. 12, pl. 32; figs 3 & 6, pl. 36.
L.: 140—172 mu; l.: 130—160 mu; Is.: 20—25 mu; lp. 68—105
mu. (6).
13. *Var. gracillima* G. M. Smith. F.D. p. 232, figs 1, 4, 7, pl. 36.
(Lac No 12).
L.: 160—185 mu; l.: 145—164 mu; Is.: 17.5—19.5 mu; lp. 92—:
98 mu.
14. *M. radiosa* Ralfs (Non Lyngb. Agardh). H.: Vol. IX, No 1, p.
81, fig. 4, p. 88.
L.: 135—195 mu; l.: 126—150 mu; Is.: 16—18.5 mu; lp.: 25—35
mu. (4).
15. *Var. extensa* (Presc. & Scott) I.—M. H. Vol. IV, No 1, p. 153,
figs 6, 7, pl. XV. (3).
L.: 130—155 mu; l.: 134—154 mu; lp.: 39—45 mu; Is.: 14—15.5
mu.
16. *Forma laurentiana* J. Brunel. N.C. Vol. LXV, No 2, p. 74, fig.
dans le texte. Voir aussi: N.C. Vol. 78, No 7, p. 189 (Lacs Nos
12 & 30).
L.: 255—290 mu; l.: 242—260 mu; Is.: 26—33 mu; lp. 55.5—65
mu.
Le lobe polaire de nos spécimens est renflé à sa base et non cunéiforme
comme les spécimens de J. BRUNEL. Fig. 15.
17. *M. rotata* (Grev.) Ralfs. F.D. p. 229, figs 5, 6, 7, pl. 39. (7).
L.: 205—290 mu; l.: 190—280 mu; Is.: 30—39 mu; lp.: 48—71
mu.



1. *Penium margaritaceum* (Ehr.) Bréb. var. *elongatum* Klebs.

2. *P. polymorphum* Ndt.

3. *Pleurotaenium subcoronulatum* (Bréb.) Rabenh.

4. *Euastrum denticulatum* (Kirchn.) Gay, var. *quadrifarium* Krieg.

5. *E. dubium* Nag. var. *latum* Krieg.

6. *E. oblongum* (Grev.) Ralfs, var. *cephalophorum* W. et G. S. West.

7. *E. pectinatum* Bréb.

8. Var. *inevolutum* W. et G. S. West.

9—10. *Micrasterias truncata* formes anormales.

11. *M. crenata* (Bréb.) Reinsch. forma.

12. *M. truncata* (Corda) Bréb. forma.

13. *M. americana* (Ehr.) Ralfs forma *gaspensis* f. nov.

14. *M. apiculata* (Ehr.) Men. forma.

15. *M. radiosa* Ralfs (non Lyngb. Agardh) forma *laurentiana* J. Brunel, mais légèrement différent.

18. *M. Torreyi* Bailey. Desmids of the U.S. p. 118: Wolle (Lacs Nos 6 & 26).
L.: 275—300 mu; l.: 250—285 mu; Is.: 35—57 mu; lp.: 82.5—85 mu.

Le lac No 6 nous a fourni de nombreuses formes de cette espèce très variable; nous ne croyons pas en devoir tenir compte; cependant il en est une plus constante. Elle possède le contour variable du type, mais le lobe polaire reste celui de *M. rotata* (Grev.) Ralfs, quoique moins profondément séparé des lobes latéraux.

19. *M. truncata* (Corda) Bréb. F.D. p. 221, figs 2—7, pl. 35, fig. 2, pl. 34.
L.: 85—110 mu; l.: 95—110 mu; Is.: 15—21 mu; lp. 65—75 mu. (6).

20. *Var. semiradiata* Cleve F. D.p. 222, figs 10, 12, pl. 33. (3).
L.: 85—95 mu; l.: 96.5—100 mu; Is.: 14—18 mu; lp.: 60.5—63 mu.

21. *Var. crenata* (Bréb.) Reinsch. F.D. p. 222, figs 8 & 9, pl. 33, f. 4, pl. 34.
L.: 90—95 mu; l.: 80—82 mu; Is.: 16—19 mu; lp.: 60—65 mu. (Lacs Nos 6, 8.)

Nous avons trouvé de nombreux spécimens anormaux. Nous en figurons sans la nommer, une forme très curieuse (fig 11), commune dans le lac No 6.

Observations on the comparative ecology of lake-dwelling triclads in southern Sweden, Finland and northern Britain

By

T. B. REYNOLDSON

Zoology Department, University College of N. Wales, Bangor U.K.

INTRODUCTION

Work in progress on the ecology of triclads in British lakes was hinting at a relationship not only between the species composition but also between the abundance of triclads and lake productivity. Opportunity was taken of a visit to Lund, Sweden in 1953 to see if this could be demonstrated in a widely separated area. A further point of interest was the fact that *Polycelis nigra* (MÜLLER), a widespread and abundant species in Britain, does not occur in Sweden. A comparison of two such areas is usually instructive ecologically.

Observations were restricted to 10 Swedish lakes, partly by the time factor, partly by the availability of suitable collecting sites at the lakes. It is doubtful whether these few data would merit publication on their own account but against the background of a large body of similar data for British lakes they may be of interest to Scandinavian ecologists particularly since triclads have not been studied on similar lines before.

The observations on Finnish lakes are much more cursory. With the assistance of Dr. A. G. DAHM, opportunity was taken to sample 5 lakes on the occasion of the excursion arranged by the Congress of the International Limnological Association held in Helsinki, 1956. The shores of the Baltic Tvärminne Research station of the Helsinki University were also searched for triclads.

The work on British lakes has now been published (REYNOLDSON, 1958; a, b) and the data confirm the existence of an undoubted relationship between the chemistry of lake water and both the species composition and the abundance of triclads. It is against such a back-

ground that the Scandinavian data must be considered. Brief reference to certain qualitative aspects of Swedish populations has already been made in the afore-mentioned papers.

THE SELECTION AND LOCATION OF THE LAKES

Observations on Swedish lakes in 1953 were limited to areas within 1 day's travelling distance of Lund where the author was based. It was essential to select lakes which differed widely in productivity to afford the necessary contrast. They were therefore chosen according to the geology and utilisation of the drainage area. Productive lakes were found mainly in the agriculturally rich province of Skane but many of these when visited did not have a suitable collecting shore and this accounts in part for the small number of lakes included. Unproductive lakes were located in the border region between the provinces of Skane and Blekinge. Lake Ivösjön was sampled in 1956 as an extra to provide more data on productive lakes. The Finnish lakes were situated immediately to the N and W of Helsinki. A list of all lakes concerned is given in Tables II and III.

METHODS

To enable the triclad fauna of the lakes to be compared with one another quantitatively as well as qualitatively, collecting sites were confined to the littoral zone of gently shelving stony shores unexposed to severe wave action. As far as possible large lakes, defined as $>2.6 \text{ km}^2$ area, (-1 sq. mile) were excluded because of the multiplicity of different habitats they provide. However, this was unavoidable in certain cases (Table III) and for these larger lakes, bays comparable to small lakes were sampled. An estimate of triclad abundance was obtained by collecting for an observed time and multiplying by the appropriate factor to give an estimate of the number collected per hour. In practice, if triclads were scarce, searching was continued for 1 hour, otherwise timed collecting was carried out to provide 50—100 specimens. Although this simple method has snags fully discussed elsewhere (REYNOLDSON, 1958, b) it provides an estimate sufficiently accurate for the purpose of examining trends in relation to the chemical features of lake waters. The specimens obtained were identified alive on the day of collection. This could be done from external characters in the case of all species but those in the genus *Polycelis*. In the latter squash preparations of the reproductive organs were examined for penis shape and the presence and absence of adenodactyls (MELANDER et al., 1954). Immature *Polycelis* were allocated according to the proportion of adults, although this may give rise to some error.

A sample of lake water for chemical analysis was taken at the same time and from the same place as the triclad collections. Analyses were restricted to dissolved matter and total hardness which afford an indication of lake productivity provided local conditions are taken into account (LUND, 1957). Normally, additional analyses especially of calcium would have been made but time was not available to do these. Indeed, the writer is very much indebted to the Institute of Limnology, the University of Lund for providing the chemical data used in this paper.

In the case of the Finnish lakes, both choice of habitat and collecting time were much more limited. I am therefore indebted to Dr. A. G. DAHM who helped me with the collecting. Not only is he an expert on triclads but he is also familiar with my collecting technique. Both our observations and collections were similar and serve as a check but it is only possible to regard the data as providing evidence of presence and absence of species, i.e. qualitative. Chemical data for the lakes are mostly taken from information leaflets provided by the biological Departments of Helsinki University, and are based on sampling in July, 1955.

QUALITATIVE ASPECTS OF DISTRIBUTION

There is considerable overlap in the species of triclads found in Sweden and Britain. The main differences are the absence of *Polycelis nigra* and *P. felina* in Sweden while *Dendrocoelopsis spinosipenis* (KENK), recently recorded from Sweden (HOLMQUIST, 1953) has not been recorded from Britain (Table I). However, the number of species found in British lakes is much greater and includes *P. felina*, *Crenobia alpina* and *Phagocata vitta* which have not been collected from lakes in southern Sweden. This difference is probably related to the higher summer temperatures which prevail in s. Sweden compared with n. Britain (REYNOLDS, 1953; DAHM, 1956, b). The Finnish triclad fauna seems to resemble that of Sweden in common species, especially the absence of *P. nigra*.

In assessing distribution, presence is a better guide than absence over a range for any chemical aspect of lake water because of the wide gaps in the data. Although the Swedish records are few they show a real difference in the distribution of some species in the two regions. This is shown clearly in Figs. 1 and 2 which record the proportion of lakes occupied by the species and distribution in relation to hardness of the water (i.e. mainly calcium and magnesium). It would have been preferable to use calcium content in this way, but unfortunately such data were not available. Figure 1 (which includes Finnish lakes) and Table III illustrate that *Dendrocoelum lacteum* is

TABLE I

A comparison of the occurrence of tritrad species in s. Sweden and Britain. Only species found in lakes in one or other of the two countries are included.

	Both countries	Sweden only	Britain only
Fam. Planariidae			
Genus Planaria	<i>Pl. torva</i> (MÜLLER)		
Dugesia	<i>Dug. lugubris</i> (O. SCHMIDT)		
Polycelis	<i>P. tenuis</i> (IGMA)		<i>P. nigra</i> (MÜLLER)
	<i>P. hepia</i> E. H. & Y. MELANDER		<i>P. felina</i> (DALYELL)
Phagocata	<i>Ph. viitta</i> (DUGÈS)		
Crenobia	<i>C. alpina</i> (DANA)		
Fam. Dendrocoelidae			
Genus Dendrocoelum	<i>Dend. lacteum</i> (MÜLLER)		
Dendrocoelopsis			<i>Dend. spinosipennis</i> (KENK)
Bdellocephala	<i>Bd. punctata</i> (PALLAS)		

a much commoner species in s. Sweden than in Britain and agrees with DAHM's (1956, a) observations. *Planaria torva* also seems to be more common in Sweden and was recorded more frequently here than in any British area which has been sampled. There are also striking differences in distribution over the range of water hardness

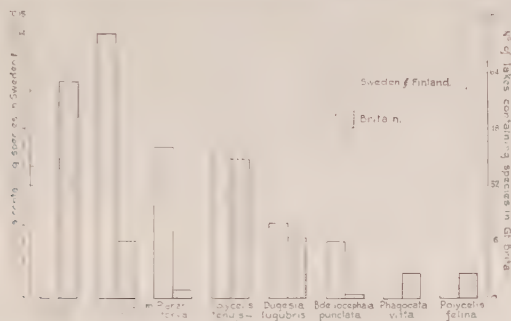


Fig. 1. A comparison of the incidence of triclads in Swedish and Finnish lakes and British lakes — note different scales.

examined in the two areas for *Dendrocoelum lacteum* (Fig. 2). It is apparent that *Dend. lacteum* has the same sort of wide distribution in Sweden which *Polycelis nigra* shows in Britain, while it is restricted in the smaller, British lakes ($< 2.6 \text{ Km}^2$) to those with a calcium content of 10mg/l. and above (total hardness, 15 mg/l. Ca + Mg). The distribution of the *Polycelis-hepta-tenuis* complex in relation

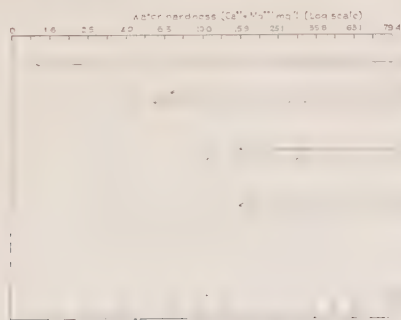


Fig. 2. A comparison of the distribution of triclads in relation to water hardness for s. Sweden and Finland (broken line) and Gt. Britain (continuous line). Dotted line includes *Dugesia* record for L. Ivösjön.

to water hardness is evidently similar in both countries. *Dugesia lugubris* (it is uncertain whether 1 or 2 species are included in the *Dugesia lugubris-polychroa* complex — see REYNOLDSON, 1956) appears to have a more restricted hardness range in Sweden but

this is probably due to the fact that no Swedish lakes were sampled between a hardness range of 13.5—38.9 mg/l., i.e. such a restricted distribution is apparent rather than real and due to shortcomings in the data. This is supported by the fact that the *Dugesia lugubris* species complex is reported from Ivösjön by DR. YNGVE MELANDER (personal communication) although it was not found in the bay near Furestad. If this 'species' is included for Ivösjön, the distribution in s. Sweden and n. Britain becomes very similar. Failure to collect *Dug. lugubris* in one sample from one bay is not surprising in view of the very large size of this lake since variation in the species complex would be expected from place to place parallel to changes in the physico-chemical conditions. In Britain *Dugesia lugubris* and *Dend. lacteum* have similar hardness ranges.

TABLE II

Water hardness and triclad species recorded from five Finnish lakes and the Baltic shore at Tvärminne.

Lake	<i>Pl. torva</i>	<i>Dend. lacteum</i>	<i>Polycelis</i> sp.	Total hardness (Ca + Mg) mg/l.	Situation
Nuurksion Pitkäjärvi	—	+	—	2.5	Espoo, Helsinki
Saaresjärvi	+	+	—	4.0	N. of Helsinki
Rasinjärvi	+	+	+	5.5	N. of Helsinki
Bodomträsk	—	+	—	7.4	Espoo, Helsinki
Kankaantakunen	+	+	+	?	N. of Helsinki
Tvärminne	+	+	+	Baltic	

All the Finnish lakes which were sampled had very soft water (Table II) and were unproductive types. Although restricted to data on the presence and absence of species, the results conform to the picture which emerged for Swedish lakes, viz. *Dendrocoelum lacteum* is the important species in unproductive lakes while *Planaria torva* is more common than in Britain. The occurrence of the *Polycelis hepta-tenuis* complex in a lake with a hardness content of 5.5 mg./l (Ca + Mg) and the apparent absence of *Dugesia lugubris* from all lakes is the result which would be anticipated from their known distribution in Sweden and Britain. A 30 minutes search of stones in the littoral zone of the Baltic at the Tvärminne Research Station yielded specimens of *Planaria torva*, *Dendrocoelum lacteum*, *Polycelis hepta* and *P. tenuis*. Although *Dugesia lugubris* was not found on

TABLE III

Recording the number of triclads collected per hour together with certain chemical and topographical data for the lakes sampled in s. Sweden arranged in ascending order of triclad populations.

Lake	Pl. torva	Dend. lacteum	P. hepta	P. tenuis	Dug. lugubris	Bd. punctata	Total	Total Hardness (Ca + Mg) mg/l.	Dissolved matter mg/l.	Altitude in m.	Area in Km ²	Collecting site	Locality
Örsjön	0	18	0	0	0	0	18	8.2	49.4	88	<1.0	N.E. Shore	**
Häckebergasjön	0	90	0	0	9	0	99	64.0	234.2	c.53	<1.0	E.	Nr. Lund
Orlunden	20	84	0	0	0	0	104	11.7	62.2	57	1.7	N.	**
St. Ålagölen	27	81	0	0	0	0	108	7.3	62.2	c.70	<1.0	N.	**
Gårdagöl	0	111	*3	0	0	0	114	13.5	100.6	c.80	<1.0	S.	**
Råbelövssjön	0	96	11	52	42	0	201	66.1	250.0	2	8.3	S.E.	Nr. Kristianstad
Uggarpssjön	0	0	66	144	0	0	210	47.8	200.0	c.65	<1.0	E.	Nr. Lund
Ivösjön	78	42	0	78	0	15	213	12.8	90.0	c.6	54.2	N.	Nr. Kristianstad
V. Ringsjön	56	44	8	232	4	4	348	38.9	148.0	c.63	14.5	N.	nr. Sjöholmen
Yddingen	3	81	0	297	9	3	393	79.7	300.0	c.30	2.	N.E.	Nr. Lund

* Only immature specimens impossible to assign to species.

** Between Olofström and Åkeholm railway station.

this occasion Prof. ALEX LUTHER told me that it did occur here. The triclad fauna of this unusual brackish water habitat therefore resembles that of a productive lake and shows that these species are able to tolerate and adapt themselves to a much higher concentration of mineral salts than they normally have to endure in freshwater habitats (see also SCHMIDT, 1955).

QUANTITATIVE ASPECTS

The quantitative data are recorded in Table III. Correlation coefficients have been obtained for the relationships between the total triclad population and (1) total hardness, (2) dissolved matter. The validity of lumping together all the species has been considered as far as present knowledge permits, in an earlier paper (REYNOLDSON, 1958, b). It was concluded that the similarity in ecology, especially a considerable overlap in food, permitted this. Both statistics are significant — for total hardness $r = 0.763$, ($0.01 < P < 0.02$), for dissolved matter $r = 0.749$, ($P = 0.02$). The relationships are also shown diagrammatically in Fig. 3a, b. It is apparent since calcium and dissolved matter account for just over half the variance that other factors influence the relationship, as would be expected. Analysis of data for British lakes showed that altitude, pollution and dystrophy were important in this respect. It was also suggested that the nature of the surrounding terrain, particularly the richness of the invertebrate fauna and the extent of the flood zone probably contributed. The precise basis of the correlations, whether direct or indirect, partially or wholly, has yet to be determined. While it is possible that physiological limitations of triclads are involved in the oligotrophic lakes (e.g. Lake Örsjön) undoubtedly the greater amount of food in the more productive lakes is an important factor.

DISCUSSION

With so few data the possibility of fortuitous results must not be discounted. However the most striking conclusion from this work, namely the very different distributions of *Dendrocoelum lacteum* in small Swedish and British lakes is well founded. Not only is it confirmed by both Swedish and Finnish data but it is supported by the evidence of Swedish zoologists interested in the group (e.g. DAHM, 1956, a). Although the survey of a large number of small, unproductive lakes in northern Britain (REYNOLDSON, 1958, a) did not yield *Dend. lacteum*, the species does occur in such large lakes as L. Windermere and Loch Lomond (SLACK, 1957) where the calcium concentrations of 5.0 and 2.3—3.3 mg/l. respectively, are

lower than its characteristic range (> 10.0 mg/l.) in smaller lakes. In these large lakes however, the populations are confined to sheltered, more productive bays with conditions perhaps comparable to those of smaller lakes with higher calcium contents; their presence here does not necessarily contradict conclusions reached from smaller lakes (cp. BOYCOTT, 1936; MACAN, 1950; HUNTER, 1957 on Mollusca). A careful study of the chemistry and ecology of such habitats should be instructive and indicate the relative importance of physiological and ecological factors in the distribution not only of *Dend. lacteum* but also other species such as *Dugesia lugubris* which occur outside their usual chemical range in large lakes. It is also true that a few records of *Dend. lacteum* from harsh stream conditions (e.g. low calcium, moorland) occur in the literature. At first, these were regarded as possible cases of confusion with *Phagocata vitta*, another white triclad which can live in this type of habitat in Britain (REYNOLDSON, 1956). Latterly, the author has confirmed the presence of *Dend. lacteum* in such a habitat. The fact demonstrated by Swedish lakes that *Dend. lacteum* can live in a wide range of conditions makes such records less anomalous. It is interesting to note (VAN OYE 1941) that the distribution of *Dend. lacteum* in Belgium, where *Polycelis nigra* is common, also appears to resemble the British situation. *Polycelis tenuis* is not mentioned from Belgium although it occurs in neighbouring countries.

Judging from conditions in British lakes, it might be anticipated that in the absence of *P. nigra* (as in Sweden) *Polycelis tenuis* or *P. hepta* would spread into lakes of a lower calcium range, as seems to happen under special circumstances in tarns of the English Lake District (REYNOLDSON, 1958, a). Apparently, this has not occurred in Sweden and Finland although more lakes in the 2.0—5.0 mg/l. calcium range need to be examined. An obvious explanation for the situation in Britain would be that *Polycelis nigra* is involved in some way in restricting the habitat range of *Dend. lacteum*. However, the obvious is not always the correct explanation in nature and the problem requires careful study. Actually, such evidence as there is on structure, food range, population size, etc. suggests that *Dend. lacteum* is the least likely of the common species to compete with *P. nigra*. But in habitats where food particularly may reach critical, low levels, competition for it may occur or an unsuspected and unrecognised factor may become important. Physiological races of *Dend. lacteum* may be involved but this appears unlikely since the species seems to have the same potential range in both areas.

The much more widespread occurrence of *Planaria torva* in Sweden compared with Britain is also striking and seems to be a real difference. In the latter country *Pl. torva* was found in only

2 out of 82 lakes (i.e. 2%) compared with 67% of the Scandinavian lakes. *Polycelis nigra* might be similarly involved in restricting the distribution of *Pl. torva* in the less productive lakes in Britain. On the other hand the species' history might explain the contrast; *Pl. torva* may be a late arrival in Britain. *Bdellocephala punctata* also seems to be more widespread in Sweden but this might well be an artifact due to the few data. For example, this species varies locally in its occurrence in Britain, being relatively more common in the English Lake District than elsewhere.

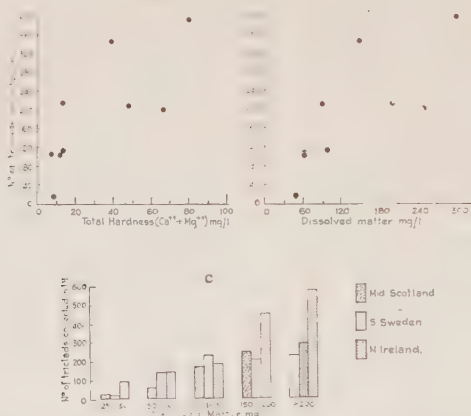


Fig. 3. Relationship between triclade numbers and a) total hardness, b) dissolved matter contents of Swedish lakes. c) A comparison of triclade populations in Mid-Scotland, s. Sweden and N. Ireland based on dissolved matter content of water.

The relationship demonstrated between the two chemical properties of the lake water and the total triclade population of the littoral zone is of the same order as shown for several areas in Britain. In the latter country a broad relationship between climate and size of the triclade population was suggested with N. Ireland populations being largest and Mid-Scotland the smallest. Figure 3c compares the size of Swedish populations with those of Mid-Scotland and N. Ireland over similar ranges of dissolved matter content of lake waters. Although the Swedish data are few they suggest 'in toto' that Swedish populations fall somewhere between the British extremes. There is also a hint that they incline more to those of Mid-Scotland, particularly at the eutrophic end of the series. It is of interest to consider these tentative conclusions in relation to climatic differences between the countries. The main contrast in climate between s. Sweden and Mid-Scotland is not so much in the average air temperature (annual monthly averages 7.3°C and 8.6°C respectively) but in the sea-

sonal changes. In s. Sweden lakes are commonly frozen over for 3 months while May to September is appreciably warmer than in Mid-Scotland (Table IV). The similarity in size of the triclad population in both areas suggests that adverse winter conditions are balanced by more favourable summer conditions in s. Swedish lakes. A comparison of the seasonal breeding cycle of the various species in the two areas would be instructive. In any case, it is clear that triclads are able to persist in longer, colder winters than experienced in Britain. They may of course, avoid extreme cold by moving from the littoral zone to deeper water in winter as reported for habitats in Belgium (VAN OYE, 1941); DAHM (private communication) has also found a winter scarcity of triclads in the littoral zone of Swedish lakes. The data are too few to permit the examination of any numerical influence of one species upon another as made for British lakes (REYNOLDSON, 1958, b).

TABLE IV

A comparison of the average monthly air temperatures (°C) in s. Sweden (1901—30) and Mid-Scotland (1901—30).

	Jan.	Feb.	Mar.	Apl.	May	Jne.	
S. Sweden (Lund)	—0.3	—0.6	1.7	5.3	10.6	14.2	
Mid-Scotland	3.6	4.4	5.0	7.0	10.3	13.1	
	Jly.	Aug.	Sep.	Oct.	Nov.	Dec.	Av.
S. Sweden (Lund)	16.6	15.3	12.2	7.9	3.4	0.9	7.3
Mid-Scotland	14.7	14.7	12.0	9.2	5.3	4.4	8.6

In previous papers already quoted, the author has attempted to categorise lakes both by the triclad species they contain and the total number of triclads. Clearly, on a species basis there is no common scheme for Swedish and British lakes but such a scheme for Sweden does seem possible if more data were available. On a quantitative basis also, this is possible and here Swedish and British conditions are not very dissimilar.

ACKNOWLEDGEMENTS

I am indebted to the Leverhulme Trust for an award which enabled me to work in Sweden in 1953 and to the Royal Society for a grant in 1956 towards expenses for the visit to Sweden and Finland. I also wish to acknowledge the generous assistance of Mr. ANDERS. G. DAHM Fil. dr., both in the field and in the preparation of the paper. Mr. F. J. H. MACKERETH kindly provided chemical data

for some of the Finnish lakes. I wish to thank MISS RUTH ISRAEL for translating the summary into German.

SUMMARY

There are more lake-dwelling species of triclad in northern Britain (10) than in southern Sweden (7) and the distribution of some differ in the two countries over approximately comparable types of lake. *Dendrocoelum lacteum* (MÜLLER) occurs in a wide range of lake types in s. Sweden but is restricted to more productive lakes in n. Britain. *Polycelis nigra* (MÜLLER) (absent from Sweden) has a similar, wide occurrence in Britain. *Planaria torva* (MÜLLER) is more common in s. Sweden in lakes of all types but particularly in the less productive lakes. The *Polycelis* species *P. tenuis* (IJIMA) and *P. hepta* E. H. and Y. MELANDER, also the *Dugesia lugubris* species complex show much the same distribution in both areas. *Polycelis felina* (DALYELL) does not occur in Sweden. The small number of Finnish lakes sampled confirm the data for s. Sweden. There is significant correlation between the total abundance of triclads and both the hardness and dissolved matter contents of the Swedish lake waters. Quantitatively the s. Swedish triclad populations compare most closely with those of Mid-Scotland in the n. Britain area.

ZUSAMMENFASSUNG

Es gibt im Norden Britanniens eine grössere Anzahl von Tricladen (10) die Süsswasserseen bewohnen, als in Süd-Schweden (7) und einige Sorten verbreiten sich in ungefähr gleichen Arten von Seen in verschiedenem Maasse in den beiden Ländern. *Dendrocoelum lacteum* (MÜLLER) erscheint in einer grossen Reihe verschiedenartiger Seen in Süd-Schweden, beschränkt sich aber im Norden Britanniens auf die Seen mit grösserem Reichtum an Lebewesen. *Polycelis nigra* (MÜLLER) — in Schweden nicht vorhanden-, hat eine ähnlich weite Verbreitung in Britannien. In Süd-Schweden ist in Seen aller Art ein reicherer Bestand an *Planaria torva* (MÜLLER), besonders in den Seen mit geringerem Bestand an Lebewesen. Die *Polycelis* Art *P. tenuis* (IJIMA) und *P. hepta* E. H. und Y. MELANDER und auch der *Dugesia lugubris* Arten-Komplex zeigen dieselbe Verbreitung in beiden Gegenden. *Polycelis felina* (DALYELL) kommt in Schweden nicht vor. Die kleine Zahl finnischer Seen, denen Proben entnommen wurden, bestätigen die Befunde von Süd-Schweden. Wesentlicher Zusammenhang besteht zwischen der gesamten Reichhaltigkeit von Tricladen und dem Gehalt an Kalk und aufgelöster Substanz bei den

schwedischen Süsswasserseen. Mengenmässig ist die Verbreitung von Tricladen in Süd-Schweden der im Norden Britanniens am ehesten zu vergleichen, soweit es sich um Mittel-Schottland handelt.

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Matériel pour la récolte du microplankton dans les mares et étangs

E. FAURÉ-FREMIET

Collège de France et Centre de Recherches Hydrobiologiques du
C.N.R.S. à Gif.

I.

Le naturaliste qui recherche dans les petites collections liquides telle ou telle catégorie d'organismes n'a généralement pas besoin d'instruments standardisés ou normalisés; selon les objets qu'il se propose de récolter dans le milieu aquatique choisi, son expérience personnelle lui permet d'utiliser pour le mieux quelque filet troubleau, ou quelque épuisette, ou quelque filet fin qu'il peut se procurer dans le commerce, mais que, bien plus souvent, il aura construit lui-même ou fait construire à peu de frais d'après ses propres indications.

Le matériel décrit ci-après n'apporte aucune solution nouvelle; il est plus particulièrement adapté à la récolte des Protozoaires et du microplankton mais il peut être utilisé à des fins différentes. La grande maniabilité de cet instrument nous a rendu de grands services au cours de nombreuses années d'explorations sur les rives des mares et des étangs, c'est pourquoi il ne nous semble pas inutile d'en faire connaître les caractéristiques, étant entendu, toutefois, que les mesures indiquées fixent seulement un ordre de grandeur.

Notre matériel de pêche a été facilement construit dans les ateliers du Collège de France et des laboratoires du C.N.R.S. à Gif; il comporte un manche démontable en duralumin sur lequel on peut fixer rapidement l'un ou l'autre des objets suivants:

- un petit filet fin en nylon qui sera longuement décrit,
- un filet type épuisette,
- une petite drague,
- un crochet,
- une pince pouvant tenir un petit flacon à large col.

II. MANCHE

Le manche démontable (Fig. 1) est fait en tubes de duralumin de 1mm. d'épaisseur; le modèle normal comporte deux segments: le

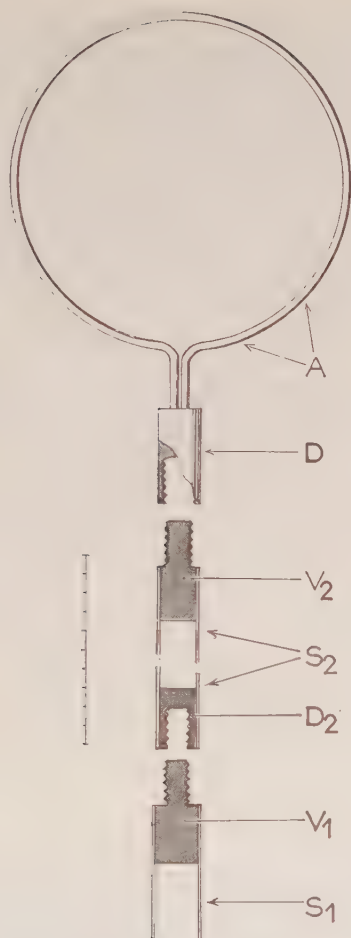


Fig. 1. Armature du filet. S_1 , premier segment du manche portant à un bout la pièce filetée V_1 . S_2 , deuxième segment portant à une extrémité la pièce filetée V_2 et à l'autre la douille filetée D_2 . A, cercle de laiton monté sur la douille filetée D qui se visse sur les pièces V_2 ou V_1 .

Echelle correspondant à 10 cm.

premier (S_1) de 25 mm. de diamètre (extérieur), long de 1 m. 10, dans lequel peut coulisser, après démontage, le deuxième (S_2) dont le diamètre extérieur est de 22 mm. et la longueur de 1 mètre environ.

A chaque extrémité du deuxième segment se trouve sertie une pièce de laiton; l'une d'elles, mâle, est prolongée par une tige filetée longue de environ 24 mm. (V_2); l'autre est une douille femelle, filetée au même pas (D_2). Le premier segment porte à l'une de ses deux extrémités une pièce mâle avec une tige filetée (V_1) qui se visse dans la

pièce femelle (D_2) du deuxième segment tandis que l'autre extrémité reste ouverte pour loger ce segment lorsque le manche est démonté.

La longueur totale du manche normal monté atteint 2 mètres 10 ce qui suffit à nombre de prélèvements; on peut, dans quelques cas, l'allonger jusqu'à 3 mètres 10 en vissant sur le deuxième segment un autre semblable, mais l'engin devient beaucoup moins maniable.

Le poids du manche normal ne dépasse guère 520 gr.; il est commode de le porter dans un étui de toile pour canne à pêche pourvu d'une poche latérale dans laquelle on rangera le crochet et la pince.

III. FILET FIN

Entièrement et rapidement démontable, le filet fin comporte une monture métallique, une poche filtrante, une bonnette de triage et un flacon récepteur.

La monture (Fig. 1, A) est constituée par une tige de laiton de 5 mm. courbée en un cercle de 180 mm. de diamètre, et dont les deux extrémités libres sont redressées parallèlement l'une à l'autre, puis

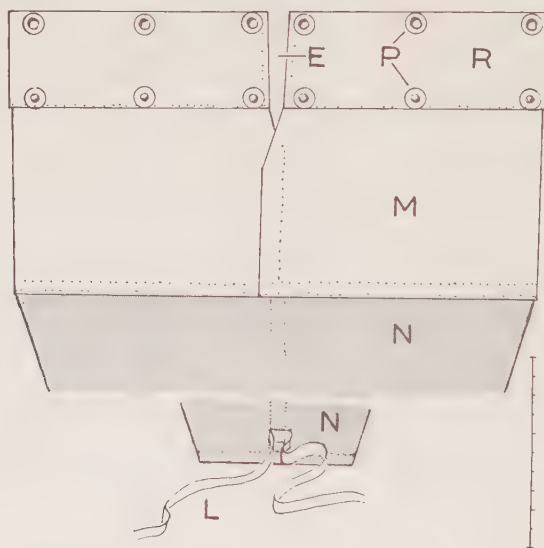


Fig. 2. Poche filtrante pliée à plat.

M, manche de toile avec son repli R, l'échancrure E et les boutons pression P;
N, N, cône filtrant en gaze de nylon avec le lacet de fermeture L.

serties, soudées, ou vissées dans une douille de laiton D, haute de environ 50 mm., large de 22, filetée à l'autre extrémité qui se visse sur l'une des pièces mâles du manche.

La poche filtrante (Fig. 2 et 4) est un cône de soie de nylon N haut

de environ 30 cmt, ouvert à sa partie inférieure étroite, et solidement fixé par son bord antérieur à une manche de grosse toile, M, cylindrique ou légèrement tronc cône. Cette pièce de toile est haute d'une quinzaine de centimètres; son bord libre est consolidé par un repli de 50 mm. échancré suivant une des génératrices E, et portant sur sa face externe une série de boutons pression P dont les moitiés mâles et femelles s'opposent, les unes au bord inférieur et les autres au bord supérieur.

Pour monter le filet fin on introduit le bord libre renforcé du cylindre de toile dans le cercle de laiton, puis on le rabat autour de ce dernier et l'on ferme les boutons pression, l'échancrure correspondant au manche reliant le cercle métallique à la virole.

En ce qui concerne le cône filtrant et son utilisation pour la récolte des Ciliés et des organismes du microplankton, nombre d'essais nous ont montré que les meilleurs résultats étaient obtenus avec un tissu de Nylon assez serré, très souple, constitué par l'entrecroisement de faisceaux plats de fils très fins (environ 15 μ de diamètre); la Fig. 5 montre la microphotographie en lumière polarisée du tissu Fyltis n° 420 que nous utilisons.

Il n'est pas douteux que ce tissu peut, éventuellement, laisser passer à travers ses mailles assez irrégulières, quelques Ciliés aussi gros que des Stentor; il suffit néanmoins à canaliser et à retenir, sans les léser, un très grand nombre de microorganismes beaucoup plus petits.

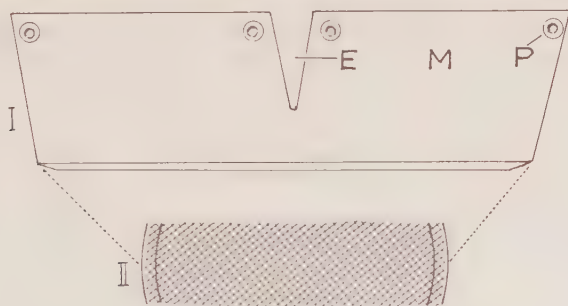


Fig. 3. I. Bonnette pliée à plat.

M, courte manche de toile avec les boutons pression P et l'échancrure E.

II. Une partie du disque de soie à bluter en crin de nylon.

L'addition d'une bonnette de triage (Fig. 3 et 4) coiffant l'ouverture du filet fin a pour objet de retenir et de soumettre au lavage les éléments ou les débris végétaux ainsi que les organismes animaux non microscopiques.

Cette bonnette est constituée (Fig. 3, II) par un disque de soie à bluter de nylon à mailles larges (0.8 à 1 mm.) fixé sur une pièce de toile de forme tronc-conique (Fig. 3, I) dont le bord externe se rabat par

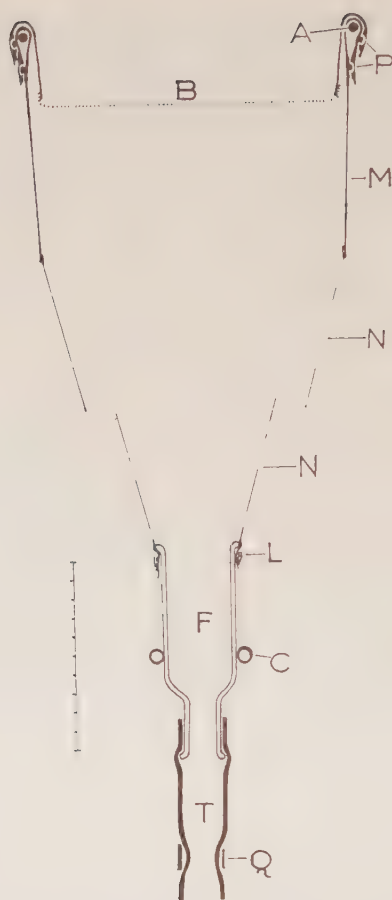


Fig. 4. Coupe longitudinale du filet monté. A, monture circulaire; M, manche de toile; N, cône filtrant de nylon; F, flacon récepteur serré sur le cône filtrant par la ligature L; T, tube de caoutchouc fermé par la pince de Mohr Q; C, anneau protecteur en caoutchouc.

Echelle correspondant à 10 cm.

dessus la monture annulaire et se fixe par quelques boutons pression à l'entoilement qui porte le cône filtrant du filet fin.

Le flacon récepteur (Fig. 4) est un entonnoir cylindrique en verre pyrex, F, large de près de 40 mm, haut de environ 80 mm, rétréci à sa partie inférieure qui se termine par une tubulure large de 10 mm environ, longue de près de 30 mm. Les deux bords supérieur et inférieur sont bordés et ourlés par un léger rebord externe.

Pour monter l'entonnoir on introduit son bord supérieur dans l'ouverture inférieure du cône filtrant à laquelle est fixée la boucle d'un

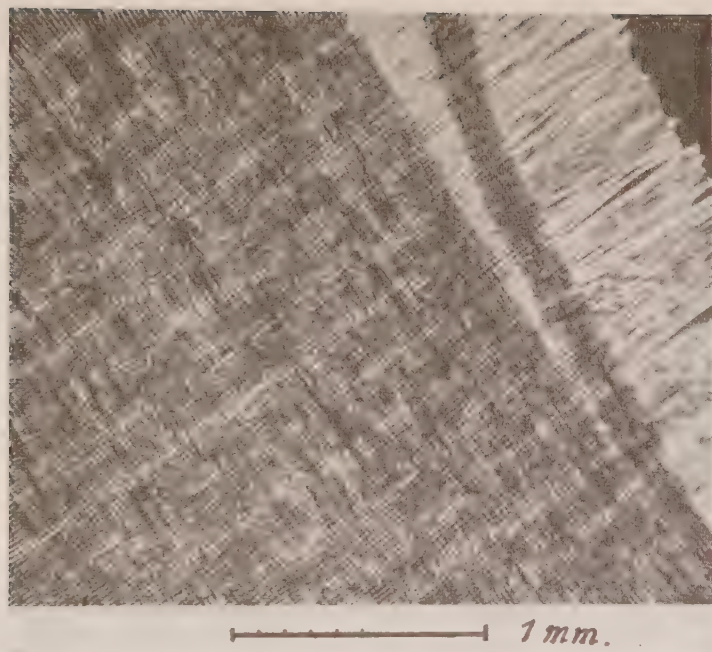


Fig. 5. Microphotographie de la gaze de Nylon Fyltis n° 1420 (lumière polarisée).

cordonnet; on tourne les deux extrémités libres du cordonnet autour de la gaze de nylon en serrant celle-ci contre la paroi de verre, au dessous de son rebord externe. Le tube inférieur de l'entonnoir est muni d'un tube de caoutchouc T, long de 60 à 80 mm, que l'on ferme en son milieu en le serrant avec une pince de Mohr à vis, Q. On réalise ainsi le flacon dans lequel se concentre la récolte à mesure que se vide le filet fin sorti de l'eau; il suffit ensuite d'ouvrir la pince de Mohr pour transvaser la pêche dans un flacon en polyéthylène à large ouverture fermée par un couvercle à vis.

La manoeuvre du filet fin sur le bord d'une pièce d'eau quelconque consiste à lui faire exécuter à vitesse modérée (en se guidant sur la résistance du milieu liquide) des ronds et des huit au niveau des couches aqueuses superficielles. Il est utile de garnir le flacon collecteur, F, de un ou deux anneaux de caoutchouc, C, épais, pour éviter les chocs sur quelques corps durs immergés.

IV. EPUISSETTES

On peut visser sur le manche, à la place de l'armature portant le filet fin et ses accessoires, toute autre armature, plus large, et garnie d'un filet offrant assez peu de résistance au passage de l'eau pour

permettre des mouvements rapides, et capable de capturer des organismes bons nageurs: Insectes, larves, Tritons, etc.

V. CROCHET

Le crochet est constitué par une tige métallique longue de 50 à 60 centimètres, sertie dans une douille qui se visse à l'extrémité du manche de duralumin et dont l'extrémité libre est recourbée en crochet. Ce prolongement permet d'attirer des corps flottants: amas d'algues, végétations diverses: *Potamogeton*, *Elodea*, *Fontinalis*, *Ceratophyllum*, *Myriophyllum*, etc, et d'arracher celles qui sont fixées; il est particulièrement utile si l'on veut attirer et arracher des buissons radiculaires appartenant à quelques arbres littoraux, buissons qui abritent généralement un grand nombre de Ciliés, de Rotifères, de Bryozoaires, d'Hydres, etc.

VI. DRAGUE

Divers échantillons de sables, de vases et surtout de certains revêtements de Cyanophycées ou de Beggiatoa peuvent être récoltés à l'aide d'une petite pelle métallique profonde, en forme d'écope, fixée latéralement sur une douille qui peut se fixer à l'extrémité du manche de dural.

Un dispositif plus efficace, mais beaucoup plus lourd et encombrant, consiste à utiliser un flacon à deux tubulures; le tube plongeant est relié extérieurement par un tube de caoutchouc, à un tube de verre fixé par une pince au bout du manche de dural; le tube court est relié à une pompe aspirante à main. Il est alors possible d'aspirer dans le flacon des flocons d'Oscillaires ou des sédiments légers visibles à faible profondeur et sur lesquels on dirige l'ouverture du tube aspirant.

VII. PINCE

Une pince de laboratoire du type pince à noix fixée sur une douille qui se visse à l'extrémité du manche permet de manoeuvrer de petits flacons à large col de manière à cueillir en surface de petits corps flottants, ou bien de récolter un peu d'eau au fond d'un fossé.

VIII. NETTOYAGE

En cours de route le filet fin est rangé, après usage et rincage rapide, dans une poche imperméable. De retour au laboratoire il est démonté, puis la poche filtrante et la bonnette sont lavées à grande eau et séchées.

On the systematics and distribution of the molluscan genus *Siphonaria* in South Africa

by

B. R. ALLANSON, ¹⁾ M. Sc.

Department of Zoology, University of Cape Town

1. INTRODUCTION

This paper is the outcome of an investigation into the biology of *Siphonaria* occurring on the shores of the Cape Peninsula. It was soon found necessary to determine which of the large number of species reported from South African shores are valid. For this work the material collected by the author from the Cape Peninsula was augmented by preserved material present in a comprehensive collection of intertidal fauna lodged in the Department of Zoology, University of Cape Town. Further material, including that of a new species, was given by Dr. M. KALK, Zoology Department, University of the Witwatersrand. In all, material from about forty shore stations was used in the systematic analysis. Two new species are described.

Although species of *Siphonaria* are among the commonest of our shore limpets, little was known of their distribution around the South African coast. This paper offers a description of both the open shore and estuarine distribution. It does not, however, include a description of the vertical distribution since this will form part of a further paper on the biology of *Siphonaria*.

2. SYSTEMATICS

Prior to 1946 seven workers had reported 13 species of *Siphonaria* on the coast of South Africa. These were *S. concinna* SOWERBY 1824; *S. capensis* QUOY and GAIMARD 1833; *S. natalensis* KRAUSS 1848; *S.*

¹⁾ National Institute for Water Research, S. A. Council for Scientific and Industrial Research, P. O. Box 395, Pretoria.

oculus KRAUSS 1848; *S. albofasciata* KRAUSS 1848; *S. carbo* HANLEY 1848; *S. parvicostata* DESHAYES 1863; *S. tenuicostulata* SMITH 1903; *S. cyaneomaculata* SOWERBY 1906; *S. becki* TURTON 1932; *S. kowiensis* TURTON 1932; *S. adjacens* TURTON 1932; *S. anneae* TOMLIN 1944.

In 1946 HUBENDICK published a monograph on the systematics of the Pulmonate group Patelliformia, in which *Siphonaria* is included. He distinguished eleven "sectia" or subgenera on the characters of the genitalia and shell and reported that three, namely *Pachysiphonaria*, *Patellopsis* and *Siphonaria* occur on the South African



Plate Ia

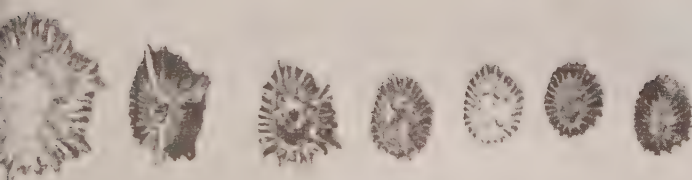
Plate I. Dorsal aspect of seven species of *Siphonaria*. The dorsal aspect of the *S. dayi* type will be found second from the left. See Pl II. Natural size.



S. ANNEAE



S. DAYI



S. ASPERA

Plate Ib.

coast and include between them twelve species. These are:

Siphonaria (Pachysiphonaria) kowiensis TURTON 1932

Synonym: ?*S. tristensis* LEACH 1824

Siphonaria (Patellopsis) capensis QUOY and GAIMARD 1833

Synonyms: *S. jonasii* DUNKER 1846; ?*S. placentula* MENKE 1853;

S. venosa REEVE 1856; *S. pectinata* (L)

Siphonaria (Patellopsis) tenuicostulata SMITH 1903

Siphonaria (Siphonaria) concinna SOWERBY 1824

Synonyms: ?*Patella deflexa* HELBLING 1779; ?*Patella leucopleura*

GMELIN 1791; *Patella melanaleuca* GMELIN 1791 in MARTENS 1874;

S. variabilis KRAUSS 1848

Siphonaria (Siphonaria) oculus KRAUSS 1848

Siphonaria (Siphonaria) natalensis KRAUSS 1848

Siphonaria (Siphonaria) aspera KRAUSS 1848

Synonym: *S. spinosa* REEVE 1856

Siphonaria (Siphonaria) albofasciata KRAUSS 1848

Siphonaria (Siphonaria) parvicostata DESHAYES 1863

Siphonaria (Siphonaria) becki TURTON 1932

Siphonaria (Siphonaria) adjacens TURTON 1932

Siphonaria (Siphonaria) cyaneomaculata SOWERBY 1906

In determining the primary divisions in the systematics of *Siphonaria* HUBENDICK (1946) has used in particular the organisation of the distal genitalia, and the relations between the veins from the gill and kidney. For the purpose of this paper only brief descriptions of these anatomical relationships are given.

Mantle cavity. The anatomy of the pallial organs in the mantle cavity has been fully described by HUBENDICK (1945). Their functions have been studied in *S. alternata* SAY by YONGE (1952). In *Patellopsis* the kidney never extends beyond the anterior efferent vein from the gill as it does in the subgenus *Siphonaria*. Posteriorly the kidney is variable in extent; in *S. oculus* it reaches the posterior



Plate IIa

Plate II. Ventral aspects of seven species of *Siphonaria*. The ventral aspect of the *S. dayi* type will be found second from the left. Natural Size.

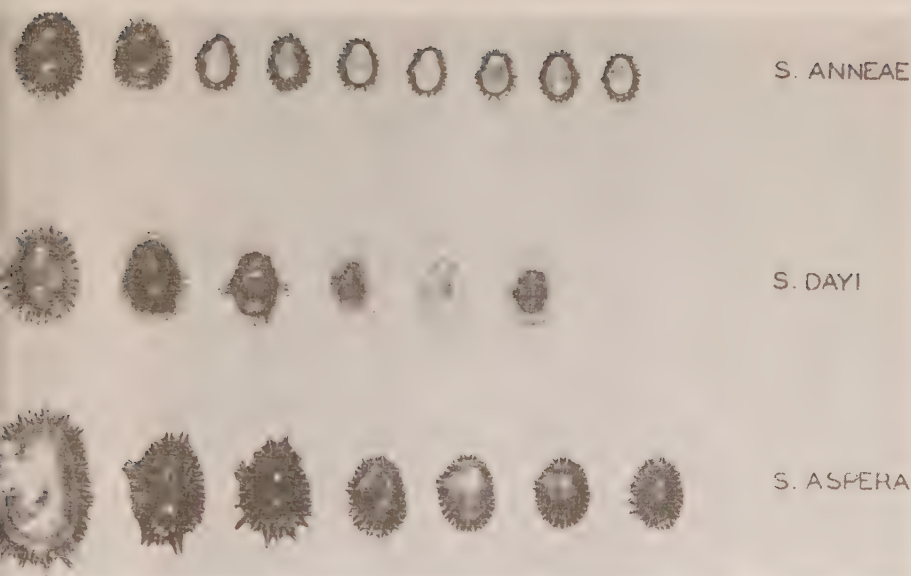


Plate IIb

efferent vein from the gill, and in *S. capensis* it reaches to about half-way between the posterior and anterior efferent veins. The dorsal aspect of the mantle cavity of *S. capensis* is shown in fig. 1.

Genitalia. HUBENDICK (1945) describes the genitalia of *Siphonaria* in detail. The species of *Siphonaria* are monaulous hermaphrodites without a true penis. The genitalia lie on the right side and together with the gut and liver occupy almost the entire sac. In the South African members, the genitalia open to the exterior by way of a pore on the right side situated in a groove between the head-lobe and foot.

A hermaphrodite gland is joined by a hermaphrodite duct to a large glandular complex similar to the albumen gland of *Helix*. A single common duct proceeds anteriorly to the genital atrium. The atrium receives a duct from the epiphallus gland, and from a spermatheca near the glandular complex. In the subgenus *Siphonaria* the atrium also bears a large accessory organ somewhat similar to the dart sac of *Helix*. A retractor muscle is attached to the proximal end of the genital atrium and its size is of some systematic importance. Both the common duct and the spermatheca duct pass through the right anterior adductor muscle. The genitalia of *S. capensis* are shown in figure 10.

Radula. The number of laterals on the radula varies in a manner which apparently has no specific significance.

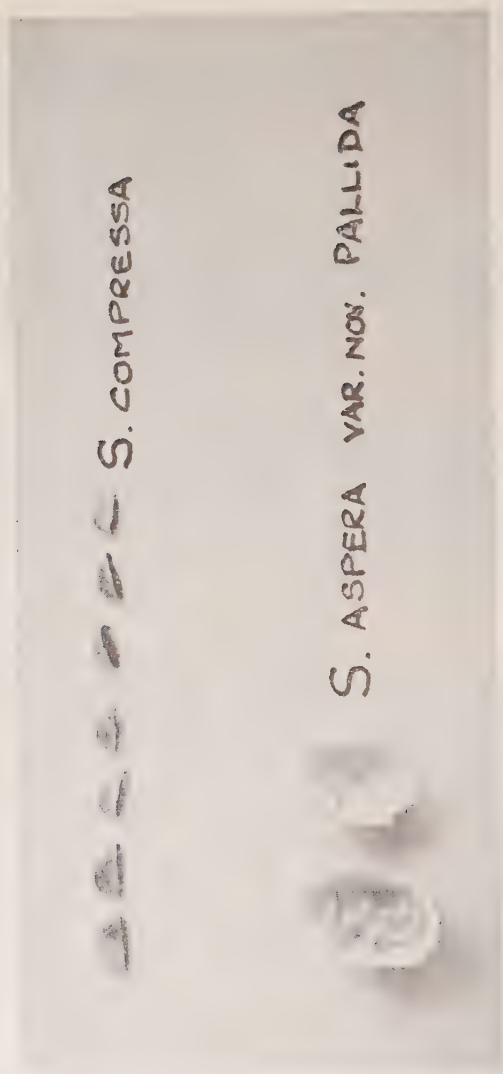


Plate III. Lateral aspect of *Siphonaria compressa* nov. sp. and ventral aspect of *S. aspera* var. nov. *pallida*

Shell. The shell of *Siphonaria* is patelloid, and the interior and exterior aspects show variation in colour and sculpturing. Plates I, II show the extent of the intraspecific variation in *Siphonaria* present on the coast of South Africa. However, the typical shells of each species possess sufficiently constant characters to make identification in the field possible. A key to the South African species is given on page 174. Where the shell characters are not well shown, the genital

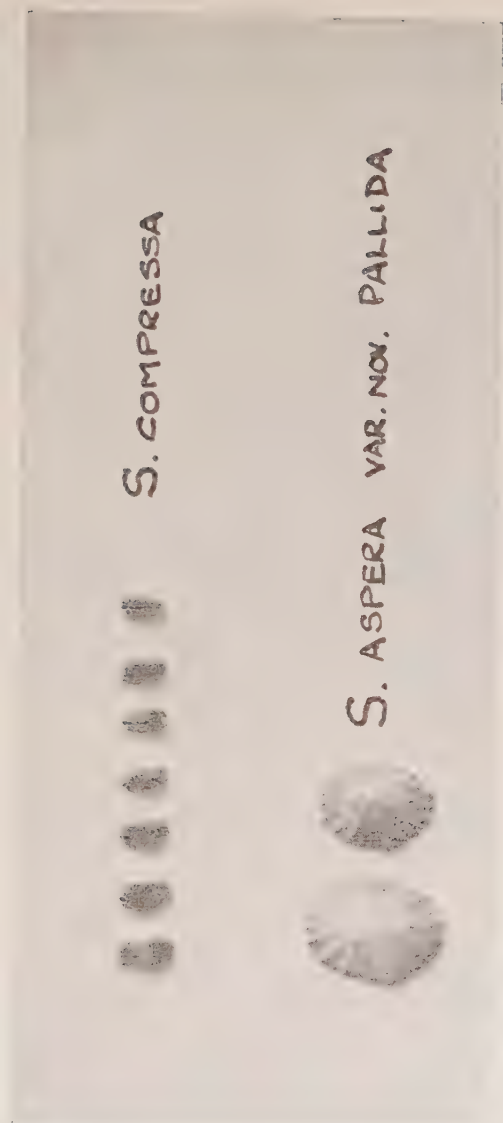


Plate IV. Dorsal aspect of *Siphonaria compressa* nov. sp. and dorsal aspect of *S. aspera* var. nov. *pallida* (X 1.5.)

arrangement and the dorsal aspect of the mantle cavity must be studied. For this purpose figures 1—18 were prepared.

It has not been possible to study the causes of shell variation within a species. COOKE (1911) has shown for *S. algiserae* that shell characters such as height and angle of apex vary between populations exposed to differing amounts of wave action. In *Siphonaria capensis*

(Plate II) the population from Green Point (Cape Town, Table Bay) is darker inside the shell than the population from Dalebrook (St. James, False Bay). This may be related to differences in respective water temperatures of these two localities. Thus in describing variants it is important to distinguish between those characters which are of genetic origin and those related to particular ecological conditions. It is doubtful whether previous authors have taken this into account. The varieties given by these authors are therefore only mentioned.

In the descriptive notes shell size is given in terms of the following table taken from HUBENDICK (1946).

Large: length over 30 mm.

Medium large: length between 15 and 30 mm.

Small: length under 15 mm.

The height of the shell is given in relation to length.

High: higher than half the length.

Low: lower than a quarter of the length.

Medium high: height between the two preceding values.

HUBENDICK (1946) includes in the subgenus *Siphonaria* a number of species which he considers are together a "genetic form group". The species in this group are: *S. concinna*, *S. becki*, *S. oculus*, *S. cyaneomaculata*, *S. adjacens*, *S. natalensis*, *S. aspera*, and *S. albofasciata*. He also states that transitions occur between these species, for example:

S. concinna \rightleftharpoons *S. oculus*

S. concinna \rightleftharpoons *S. aspera* \rightleftharpoons *S. natalensis*

The present work on freshly preserved and living material suggests that the above statements are erroneous. HUBENDICK has confused the genitalia of *S. concinna* and *S. oculus* with those of *S. aspera*. They are distinct. The two former species fall into the subgenus *Patellopsis*. Both have pronounced genital atria without an accessory organ, and the kidney does not extend beyond the anterior efferent vein from the gill. *S. aspera* belongs to the subgenus *Siphonaria*. The genital atrium bears an accessory organ and the kidney reaches in front of the anterior efferent vein. On this basis it is difficult to see how transitional forms could exist. Further, atypical shells of *Siphonaria oculus* are often confused with typical shells of *S. concinna*, but on the basis of the distal genitalia these species are distinct. In *S. oculus* the spermathecal duct, which in *S. concinna* remains narrow, is swollen just before it enters the atrium. The retractor muscle in *S. concinna* is small and narrow and is not split around the epiphallus duct as it is in *S. oculus* (Fig. 11).

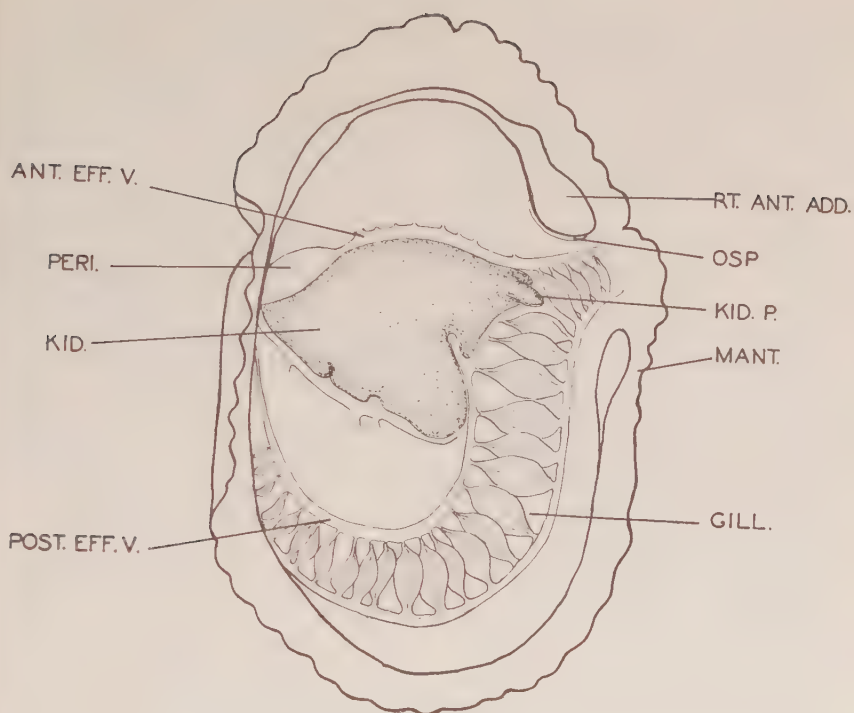


Fig. 1. *S. capensis*

Figures 1—9: Dorsal aspect of the mantle cavity. ant. eff. v. Anterior efferent vein; kid. Kidney; kid. p. Kidney pore; mant. Mantle; osp. Osphradium; peri. Pericardium; post. eff. v. Posterior efferent vein; rt. ant. add. Right anterior adductor muscle.

Siphonaria (Patellopsis) capensis QUOY and GAIMARD 1833 (pl. I, II; figs. 1, 10) QUOY et GAIMARD (1833) Voy. de l'Astr. Tome II p. 331, pl. 25 figs. 28, 29.

?*S. kowiensis* TURTON 1932 p. 10, pl. II, no. 84.

Shell small to medium large, varying from low to high: circumference symmetrical with a maximum diameter of 15 mm. The siphon is weakly marked. The apex is nearly always eroded. Pallial border of shell smooth but may be slightly crenulate due to the slight raising of 37—47 weakly developed radial ribs. Externally the shell is dirty brown in colour. The ribs are brown with white interspaces. The nacre of the shell varies from deep brown to pale brown in colour. In pale shells the deep brown radiating lines alternate with outer ribbing. The adductor muscle impression is clear.

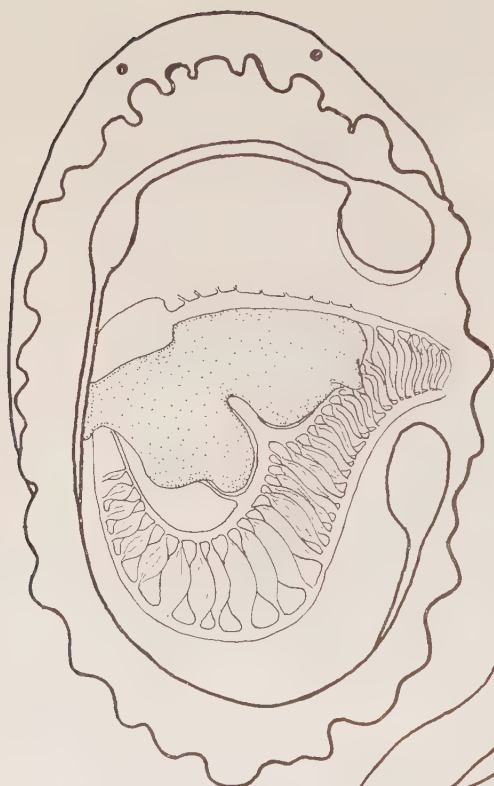


Fig. 2. *S. deflexa*

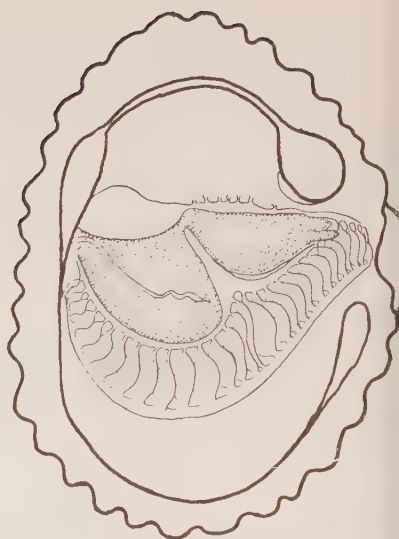


Fig. 3. *S. anneae*

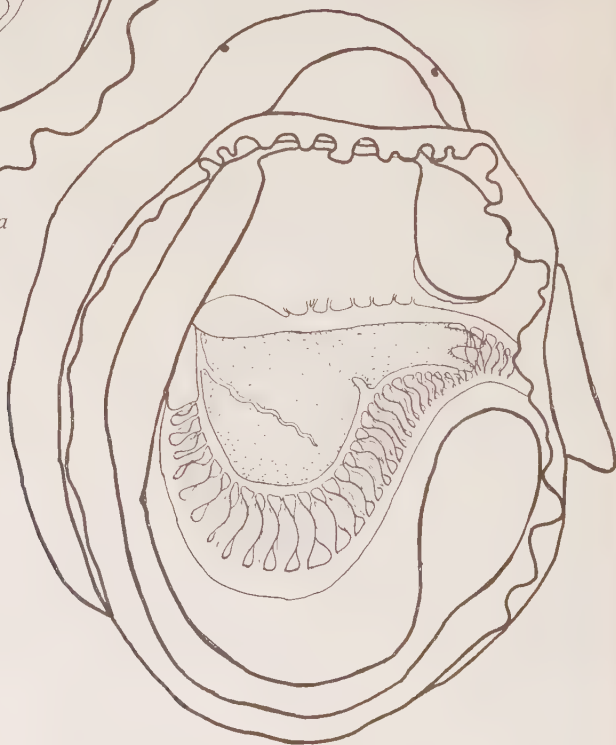


Fig. 4. *S. oculus*

The gill is deeply U shaped. The posterior border of the kidney does not reach the left branch of the posterior efferent vein from the gill.

The genitalia bears an atrium, pigmented distally and bearing a coarse retractor muscle which covers the proximal third of the atrium. The bursa duct is not swollen distally. The radula formula is 41 : 1 : 41.

The foot is arsenic yellow ventrally. The sides are variable yellow to yellowish green with numerous fine pigment spots. The head lobes do not bear eyes.

Variation: The inner colouration of the population of this species on the cold West coast of South Africa ranges from deep brown to almost black. The warmer water population from False Bay to Umpangazi is light brown, and the shell is more flattened. This form has been called by HUBENDICK (1946) *Siphonaria capensis* forma *kraussi* (non *lineolata* KRAUSS 1848).

Synonymy: On the basis of TURTON's (1932) description and figure, HUBENDICK (1945) included *S. kowiensis* in the subgenus *Pachysiphonaria* since he felt this species to be closely related to *S. (P.) tristensis* LEACH 1824 (?). TURTON's type and figure of it are poor, and HUBENDICK's statement that "the apex is distinctly behind the midline" is of little significance because the apex is eroded. In small shells of *S. capensis* the apex is often markedly behind the midline. TURTON's type has been examined. The specimen is heavily eroded and pitted, and it is difficult if not impossible to assign the specimen either to a new species or an existing one.

Distribution: Inhaca Island, Delagoa Bay to Port Nolloth.

Siphonaria (Patellopsis) deflexa (HELBLING) 1779 (Pl. I, II, figs. 2, 12) HELBLING (1779) Abhandlungen einer Privatgesellschaft in Bohemen vol. 4.

Patella deflexa HELBLING (1779) p. 108 Tab. I, no. 10, 11.

Siphonaria concinna SOWERBY (1820—25) pl. 143, fig. 2.

S. variabilis KRAUSS (1848) p. 59, Tab. IV, fig. 4a.

S. variabilis var. *albofasciata* KRAUSS (1848) p. 60, Tab. IV. fig. 4b.

S. cyaneomaculata SOWERBY (1906) Text fig. on p. 37.

S. concinna var. *adjacens* TURTON (1932) p. 2 fig. 21.

S. adjacens HUBENDICK (1946) Ser. 3, 23; 5, p. 59.

Shell medium large to large, low to medium high: circumference symmetrical, but may be slightly asymmetrical with a maximum diameter of 20 mm. The apex is worn to form an extensive elliptical area showing no traces of ribbing. About 24—27 well developed ribs project from the shell margin, and the pallial edge of the shell is turned outwards. The shell externally is dirty greyish brown, often

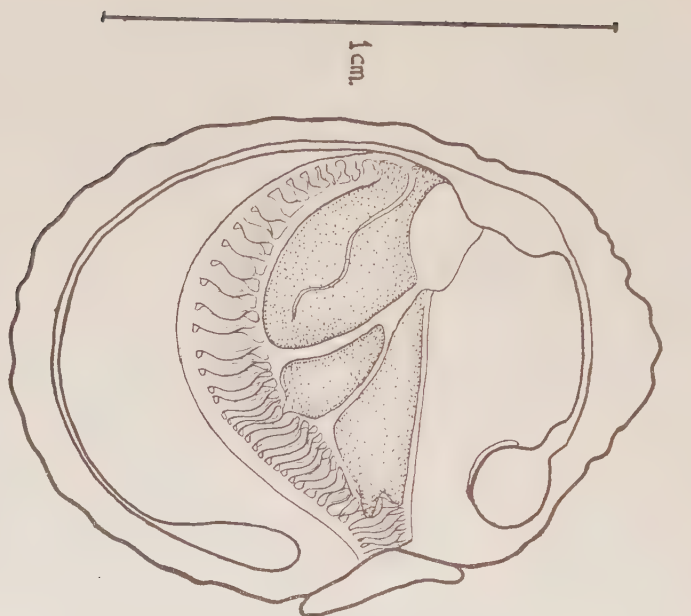


Fig. 5. *S. dayi*

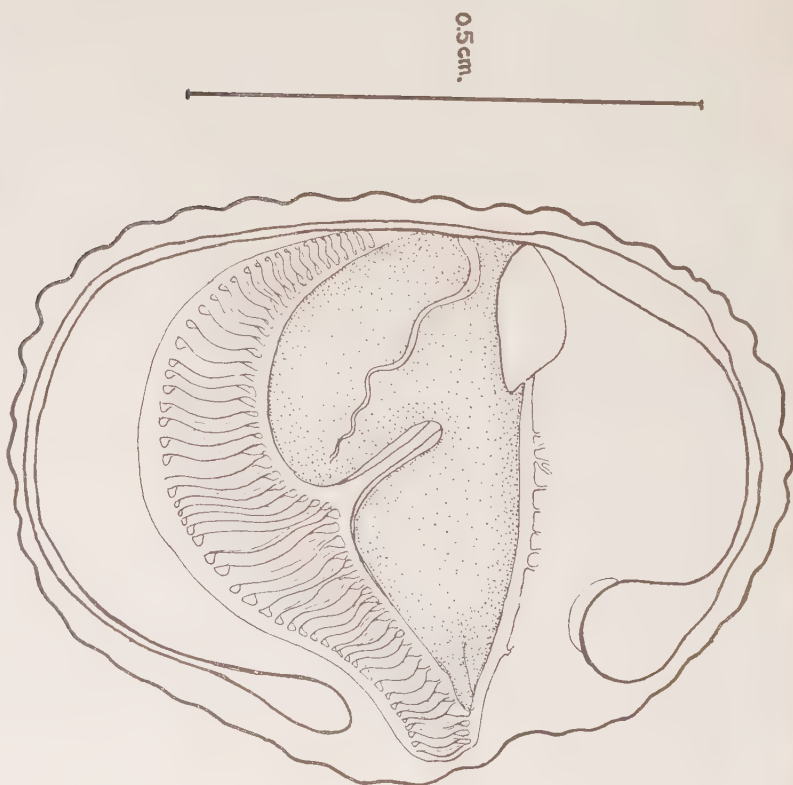


Fig. 6. *S. carbo*

with numerous blue-green iridescent spots on the interspaces. The ribs may be formed into broad white plates. Internally the shell of this species is characterized by a variably extensive white apical spot limited by a deep brown or black band below the adductor muscle impression. This band is traversed by thin radiating white lines, corresponding to the external ribbing. The adductor muscle impression is weakly marked. The siphon is marked internally by an invasion of white from the apical area.

The gill is moderately U shaped. The kidney does not quite reach the left branch of the posterior efferent vein from the gill. This is, however, a greater posterior extension of the kidney than in *S. capensis*.

The genitalia possesses a narrow fusiform atrium bearing a delicate retractor muscle proximally where the epiphallus and spermatheca ducts open separately. The spermathecal duct is not swollen distally, but remarkably narrow. The radula formula is 48 : 1 : 48.

V a r i a t i o n: This is a very variable species. Internally the shell always shows a white central spot which is variable in width, but in typical shells takes up the entire area within the adductor muscle impression. Externally, the elliptical area formed by erosion of the apex often reaches to halfway between its centre and the shell margin. Where the apex is not eroded, the iridescent blue spots on the interspaces of the ribs may extend apically. Forms in which the ribs have fused to form white sectors which can cover the shell, as in plate I have been described by KRAUSS (1848) as a variety of *S. concinna* SOWERBY 1824 but are listed in HUBENDICK (1946) as *S. albofasciata* KRAUSS.

S y n o n y m y: HUBENDICK (1946) has accepted SOWERBY's (1824) name, *S. concinna*, relegating *S. deflexa* (HELBLING 1779) to a synonym. This he did because HELBLING's description was not available to him. Recently a copy of the description was studied by the author and upon this *S. deflexa* becomes of specific value. *S. cyaneomaculata* as a distinct species has not been found. The iridescent blue spots on the interspaces of the ribs are not typical of this species since they occur in both *S. deflexa* and *S. oculus*. The white central spot inside the shell is not sufficiently distinct from the completely white area within the adductor muscle impression which is typical of *S. deflexa*.

Table I shows a larger standard deviation for the populations of *S. ?cyaneomaculata* than for the populations of *S. deflexa*, suggesting a greater variation in the former "species" which overlaps the variation normally expected in *S. deflexa*.

HUBENDICK (1950) has determined the variation of a similar

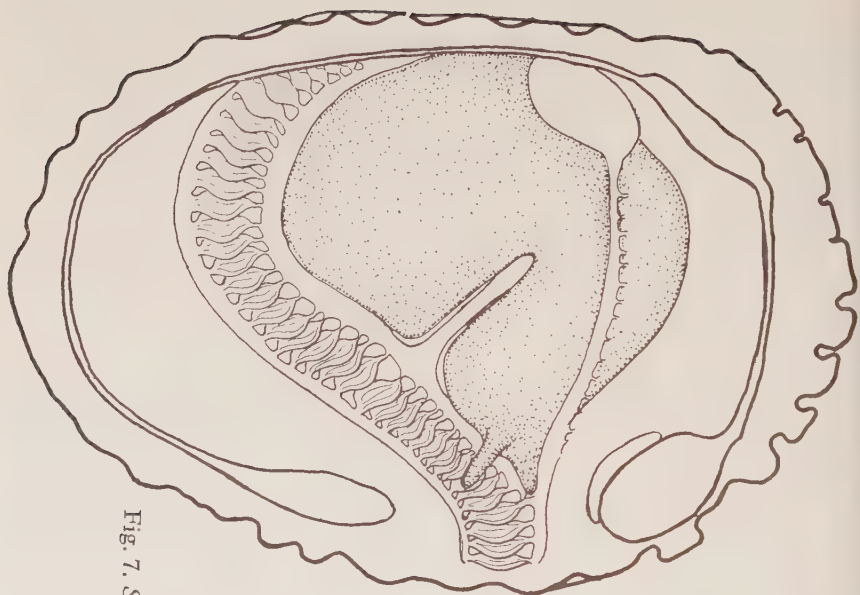


Fig. 7. *S. aspera*

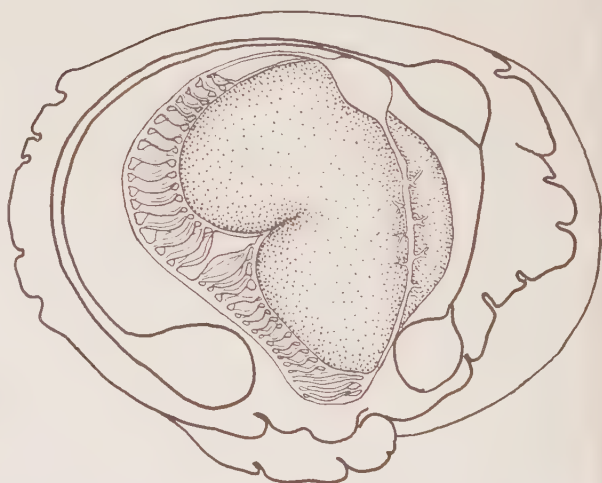


Fig. 8. *S. aspera* var. *pallida*

0.7 cm.

TABLE I

The ratio of breadth of shell to diameter of inner white central spot, and its standard deviation in two populations of *S. deflexa*, two populations of *S. ?cyaneomaculata* and one population of mixed *S. deflexa* and *S. ?cyaneomaculata*.

Population No.	Locality	No. of specimens	b d	Population
1	False Bay	30	2.66 0.66	Mixed
2	Robberg	20	2.66 0.60	<i>S. deflexa</i>
3	Port Alfred	23	2.62 0.53	<i>S. deflexa</i>
4	Umhlali	25	3.60 0.96	<i>S. ?cyaneomaculata</i>
5	False Bay	25	3.52 0.82	<i>S. ?cyaneomaculata</i>

character in *Siphonaria pectinata* on the West coast of Africa. He says "the relative breadth of the central spot shows extreme heterogenousness in its variation" and adds that "the relative diameters of the central spot . . . can hardly be supposed to be due to ecological factors". This lends further support to the argument that the relative breadth of the central spot cannot be used as a distinguishing character between *S. deflexa* and *S. cyaneomaculata*, but rather indicates that they are one and the same species.

S. albofasciata KRAUSS is not a good species and becomes a synonym of *S. deflexa*. The so called characteristic broad white ribs, often joining to form white sectors which may obliterate all signs of ribbing, do not constitute a sufficiently clear systematic difference. It has been observed that this type of shell appears singly in aggregations of *S. deflexa* which suggests the chimerical nature of this character.

TURTON's (1932) variety, *S. concinna* var. *adjacens* reported by HUBENDICK (1946) as *S. adjacens* is disregarded. TURTON's type material was taken from beach washed specimens so that the typical characters would be lost and the material taxonomically useless. I have examined the type material which is a single heavily eroded shell. The nacre is heavy. The shell has 28—29 raised ribs, and the shell colour is mottled brown with white. There is a suggestion of a transverse white bar across the internal apex, which indicates the specimen's closeness to *S. oculus*. But due to the erosion of the shell and the absence of any soft parts it is difficult to assign this specimen variety status.

Distribution: Umpangazi, Natal to Green Point, Table Bay.

Siphonaria (Patellopsis) oculus KRAUSS 1848 (Pl. I, II. figs. 4, 11) KRAUSS (1848). Die Südafrikanischen Mollusken, Stuttgart. p. 58, Tab. IV, fig. 3.

S. becki TURTON 1932 pl. II, no. 81.

Shell medium large to large, low to medium high: circumference generally symmetrical, but often with the right side bulging. The shell has a maximum diameter of 17 mm. The apex is often eroded, but is centrally placed. There are 33—43 fairly prominent ribs, usually slightly broader than in *S. deflexa*. They are not pronounced at the shell margin. Externally the shell is greyish brown in colour, often with blue-green iridescent spots towards shell margin. Internally this species is characterised by a transverse white bar slightly in front of the apex. In pale shells this bar may be lacking.

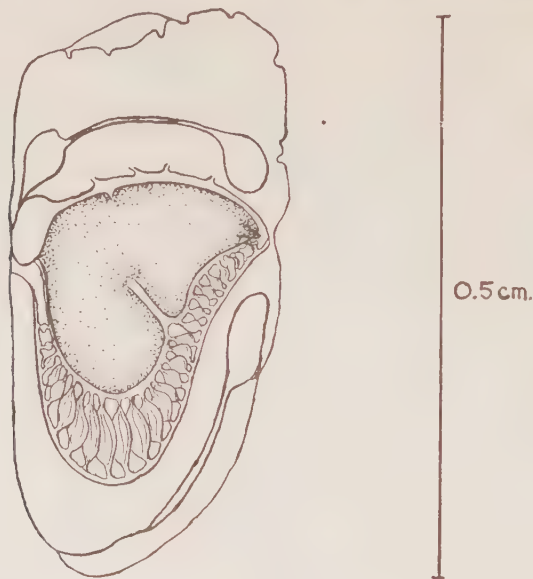


Fig. 9. *S. compressa*

The gill is deeply U shaped. The kidney extends posteriorly to the posterior efferent vein from the gill.

A fusiform genital atrium is present bearing a divided retractor muscle proximally. Only the epiphallus duct opens at the proximal end of the atrium. The spermathecal and spermoviduct open more distally. The spermathecal duct is swollen just before it enters the atrium. The epiphallus duct is shorter than in *S. deflexa* of the same shell size. Radula formula is 35 : 1 : 35.

The foot is dull greenish grey. The sides and head are flecked with black.

Variation: In False Bay where *S. oculus* is practically at the end of its geographical range, it shows variation in shell colour. The transverse bar is often absent and the shell is uniformly pale brown with darker striations alternating with external ribbing. Externally

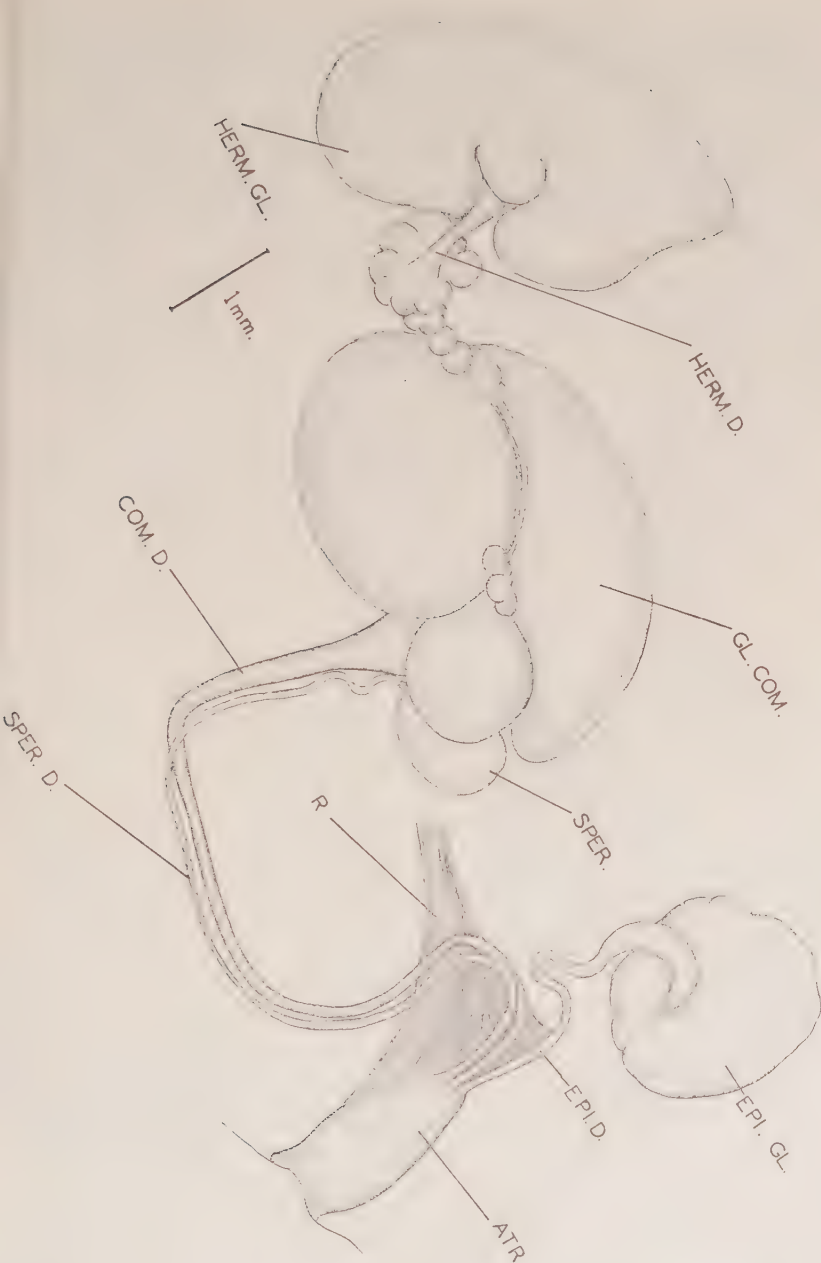


Fig. 10. *S. capensis*

Figures 10—18: Genitalia. acc. o. Accessory organ; atr. atrium; com. d. Common duct; epi. d. Epiphallus duct; epi. gl. Epiphallus gland; flag. Flagellum; gl. com. Glandular complex; herm. d. Hermaphrodite duct; herm. gl. Hermaphrodite gland; r. Retractor muscle; sper. Spermatheca.

the shells of *S. oculus* are nondescript and are often confused with *S. deflexa* and *S. aspera*. Confusion may also arise from the erosion of the apex as in *S. deflexa* though this is rare.

S y n o n y m y: *S. becki* is described by TURTON (1932) on p. 10 and figured on pl. II, no. 81. After comparing his description and figure with a less typical form of *S. oculus* it is apparent that they are very similar. This view is supported after examination of the type material.

D i s t r i b u t i o n: Inhaca Island, Delagoa Bay to St. James, False Bay.

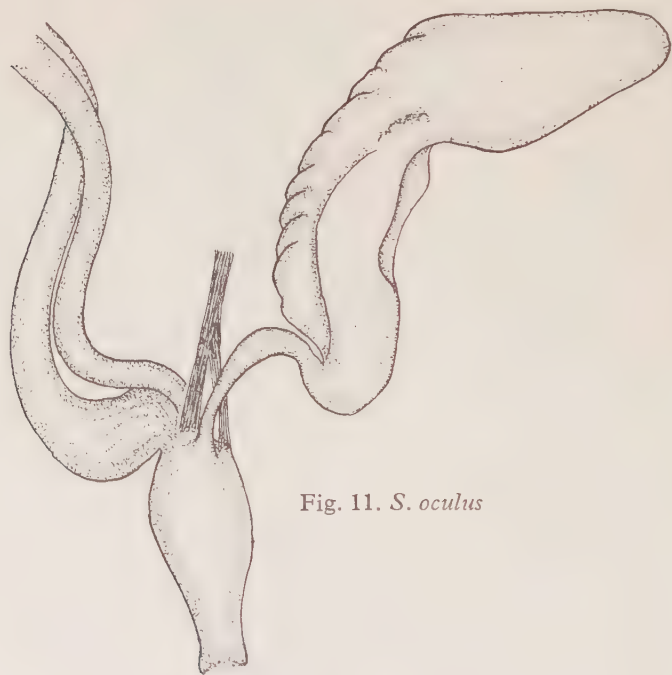


Fig. 11. *S. oculus*

Siphonaria (Patellopsis) anneae TOMLIN 1944 (Pl. I, II figs. 3, 13) TOMLIN (1944) New South African Siphonaria. J. Conch., 22, 4, p. 92 figure in text.

?*S. tenuicostulata* SMITH 1903 5, pl. 15, fig. 14—15.

Shell small to medium large, low to medium high. Siphon slightly pronounced. The circumference is symmetrical with a maximum diameter of 8.5 mm. The margin is slightly crenulate. The shell has 24—36 shallow ribs, only noticeably raised at the shell margin. The apex is central. Externally the shell colour is pale brown to white.

Internally the shell is dark brown within the adductor muscle impression. The siphon is usually marked by a broad white streak.

The gill is a shallow U. The kidney may or may not extend posteriorly to the posterior efferent vein.

The genitalia are exactly similar to *S. oculus*. Radula formula is 37 : 1 : 37.

Variation: None of the material studied showed any notable variation in either shell colour or shape.

Synonymy: HUBENDICK (1946) figures *S. tenuicostulata* in pl. 6, figs. 18, 19. His description and figures agree with the material listed G. 10 A in the collection of the Department of Zoology, University of Cape Town from which TOMLIN's types were taken. The only difference is in the number of ribs. *S. tenuicostulata* has according to HUBENDICK (1946) "about 60 fine radial ribs". TOMLIN's description reports that the holotype has about 42 ribs. This might be due to differences in shell size. The shell figured by HUBENDICK is larger than 15 mm., but that of TOMLIN's is 15 mm. in length. The anatomy of the distal genitalia in *S. anneae* is exactly similar to that described by HUBENDICK for *S. tenuicostulata*.

Distribution: Inhaca Island, Delagoa Bay to Durban.

Siphonaria (Patellopsis) carbo HANLEY 1848 (Pl. I, II figs 6, 14) HANLEY (1848) Proc. Zool. Soc., 26 London.

Full description in HUBENDICK (1946) Ser. 3, 23, 5 p. 35, pl. 6 figs. 16, 17.

Shell small, medium high: circumference symmetrical with a maximum diameter of 11 mm. The margin of the shell is slightly crenulate. The apex is central and only slightly eroded. There are 50—55 weakly developed ribs. Irregular lines of growth superimpose a mottled appearance on the shell. The external colour when dry is greyish white, and the area internally within the adductor muscle impression is slate blue. In older specimens this area is coloured brown. Internally at the edge of the shell there is an irregular white band with darker streaks corresponding to interspaces of the ribs. The adductor muscle impression is clear.

The gill is a shallow U. The kidney extends posteriorly to the posterior efferent vein.

The genitalia are exactly similar to *S. oculus* except that the retractor muscle is not so well defined. The radula formula is not determined.

The foot and head lobes are uniformly grey with no visible signs of pigmentation. The head lobes bear sessile eyes.

Variation: Insufficient material.

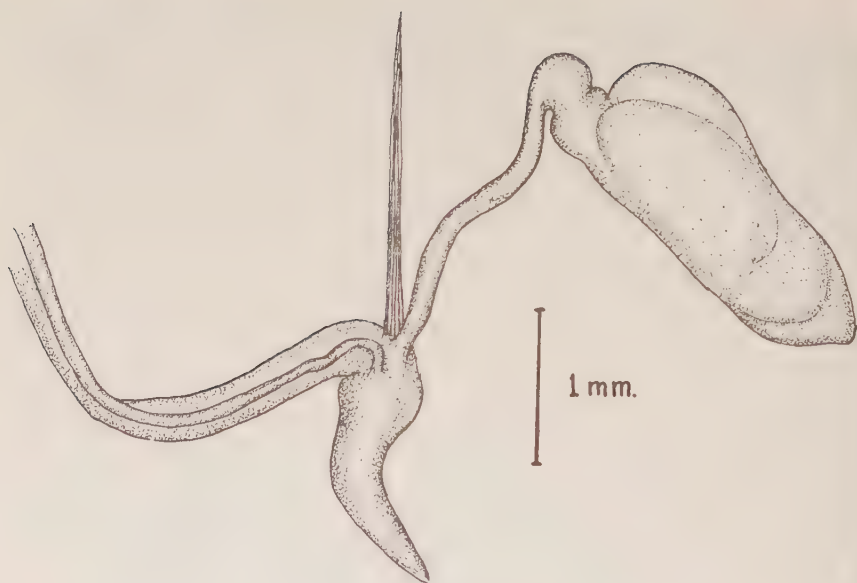


Fig. 12. *S. deflexa*

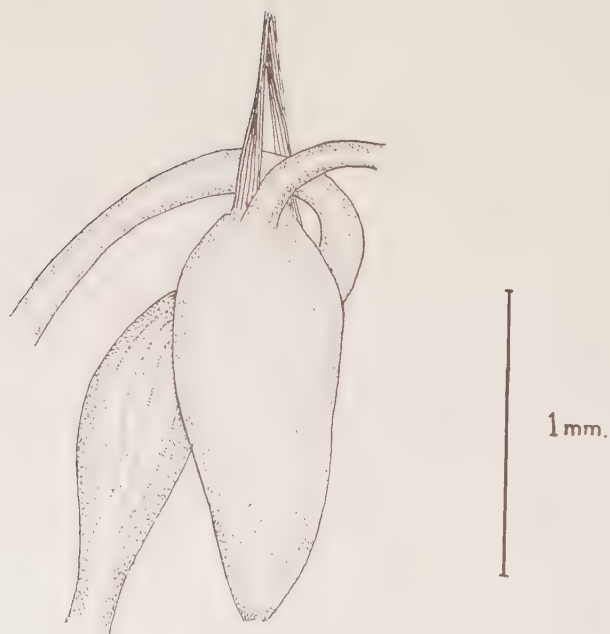


Fig. 13. *S. annea*

Notes: HUBENDICK's description and figure correspond to some degree with the material studied from Inhaca Island, Delagoa Bay. Neither the type material nor the original description were available for study. However, H. A. REHDER, Curator Division of Mollusks, Smithsonian Institute agrees that the material studied is as far as he can determine a young stage of *S. carbo*.

Distribution: Inhaca Island, Delagoa Bay to Umhlali, Natal.

Siphonaria (Patellopsis) davi sp. nov. (Pl. I, II, figs 5, 16)

Type locality: Inhaca Island, Delagoa Bay.

Type Material: Two specimens in alcohol and supplied by Dr. M. KALK of Witwatersrand University, and now in the collection of the Zoology Department, University of Cape Town. This species is dedicated to Professor J. H. DAY of this department. One specimen was sent to the Smithsonian Institute and becomes the co-type. Paratype material is composed of shells only and entire animals. This material and the type material will eventually be lodged in the South African Museum, Cape Town.

Shell medium large, low: circumference symmetrical with a maximum diameter of 11 mm. The edge is slightly crenulate. The siphon is weakly marked. The apex is eroded and centrally placed or only slightly posterior to the mid-line. 46—49 shallow ribs are only markedly raised towards pallial edge of the shell. Externally the shell colour is uniformly greyish white often with brown interspaces between the ribs. The inner colouration of the shell is striking: orange brown suffusion within the adductor muscle impression. Below this impression there are radiating brown streaks which correspond to the external ribbing.

The gill is a shallow U. The kidney extends posteriorly to the posterior efferent vein from the gill. This vein may be divided into two branches which join just before entry into the heart.

The genital atrium is fusiform bearing two powerful radiating muscles attached proximally. The spermathecal duct is swollen distally just before it enters the atrium. The epithelium of this duct is plicated. The radula formula is about 34 : 1 : 34. In the preserved type material the head and foot are pale greyish white with no trace of pigmentation. The head lobes bear two sessile eyes.

Distribution: Inhaca Island, Delagoa Bay.

Siphonaria (Siphonaria) aspera KRAUSS 1848 (Pl. I, II figs 7, 15) KRAUSS (1848) Die Südafrikanischen Mollusken, Stuttgart, p. 60, Tab. IV, fig. 5.

S. natalensis KRAUSS 1848, p. 61, Tab. IV, fig. 6.



Fig. 14. *S. carbo*



Fig. 15. *S. aspera*

Shell medium large to large, low to medium high: circumference strongly asymmetrical with a maximum diameter of 18 mm. The siphon is variably pronounced and is formed by two ribs. The apex is directed to the left side and near the mid-line of the shell. About 24—30 pronounced ribs are typically spinous. The spines may be strongly

recurved. The colour of the shell externally is variable, usually predominately brown. The shell colour internally is pale brown often mottled with darker brown. The pallial margin normally has a dark brown band.

The gill is a shallow U. The kidney extends posteriorly to the posterior efferent vein from the gill and in front of the anterior efferent vein from the gill.

The genital atrium is small, not fusiform and has a large accessory organ (muscular sheath, HUBENDICK 1946). The epiphallus duct is surrounded by extensive connective tissue. The common and spermathecal ducts open just within the genital pore. A spermatophore is normally present. The radula formula is about 40 : 1 : 40.

The foot is dirty greenish yellow. The sides are translucent greyish blue in living specimens. Pigment is aggregated into patches giving a mottled appearance. The head lobes bear sessile eyes.

Variation: The internal colouration of the shell of populations of this species on the cold West coast of South Africa is darker (cf. *S. capensis*) than those in the warmer waters of False Bay. Eastward from Port Elizabeth *S. aspera* is depressed and often has strongly recurved spines. From the Durban region the ribs of this species extend further from the shell margin and they are not so spinous and may even be smooth. This possibly might be due to exposure to wave action. KRAUSS (1848) and HUBENDICK (1946) both list the animal from Durban as a valid species of *S. natalensis*.

Synonymy: KRAUSS (1848) and HUBENDICK (1946) emphasize the arrangements of the radial ridges of the shells in describing *S. natalensis*, and in particular the two pronounced ridges which form the siphon groove on the right side. These two ridges are present to a lesser degree in the elevated shells of *S. aspera*. The anatomy of the distal genitalia of *S. natalensis* agrees in all respects to that of *S. aspera*. The internal colouration of *S. natalensis* is within the range of *S. aspera*.

Distribution: Umpangazi, Natal to Zout River, West coast.

Siphonaria (*Siphonaria*) *aspera* var. *pallida* nov. var. (Pl. III, IV Figs. 8, 17).

Type locality: Langebaan Lagoon, Saldanha Bay.

Type Material: Four specimens in alcohol supplied by Professor J. H. DAY, Department of Zoology, University of Cape Town. This material is deposited in the South African Museum, Cape Town. This variety is so named because of its pale shell colour. The specimens were collected from an intertidal rock ledge shaded from the sun.

Shell small, medium high: circumference slightly asymmetrical

with a maximum diameter of 9 mm. The siphon is clearly marked by two radiating and raised ribs. The edge of the shell is slightly crenulate. The apex is strongly curved to the left and directed posteriorly.

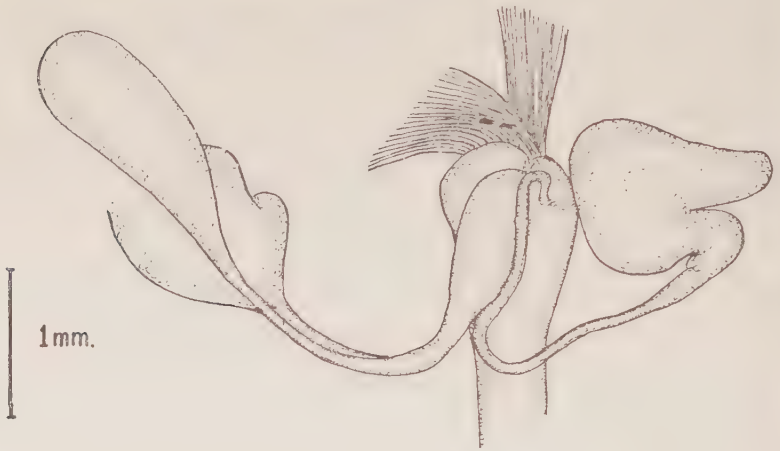


Fig. 16. *S. dayi*



Fig. 17. *S. aspera* var. *pallida*

The shell has 29 radial ribs which bear weakly developed spines. The shell colour externally is creamy white while internally the same colour predominates with a small brown spot within the adductor muscle impression. In two the shells of the type material the pallial edge of the shell is flecked with brown.

The gill is a shallow U. The kidney extends posteriorly to the posterior efferent vein from the gill and in front of the anterior efferent vein from the gill. In this respect the specimen falls into the sub-genus *Siphonaria* s. str.

The genitalia is nearly in all respects similar to that described for *S. aspera*, but the accessory organ (muscular sheath, HUBENDICK 1946) is smaller and no spermatophore has been found. The radula formula is about 30 : 1 : 30.

The foot is creamy grey, mottled with black. The sessile eyes are not distinguishable on the head lobes.

Distribution: Langebaan lagoon, Saldanha Bay, West coast of South Africa.

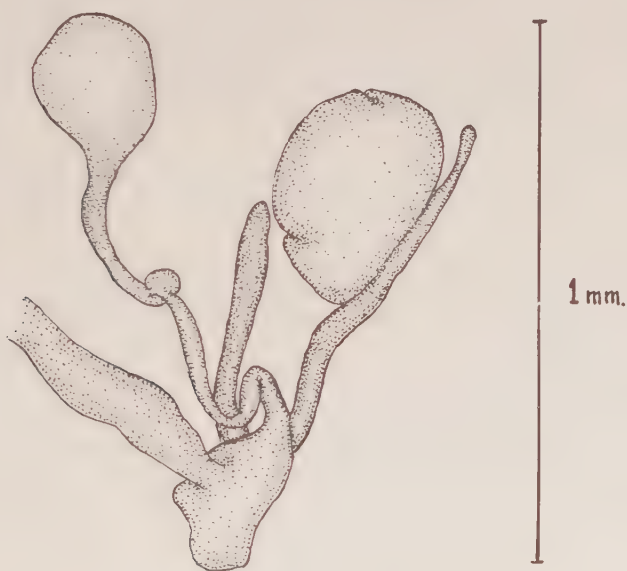


Fig. 18. *S. compressa*

Siphonaria (*Sacculosiphonaria*) *compressa* nov. sp. (Pl. III, IV figs. 9, 18).

Type locality: Langebaan Lagoon, Saldanha Bay.

Type material: Ten specimens in alcohol, supplied by Professor J. H. DAY, University of Cape Town. The species is so named because of its striking similarity in shape to *Patella compressa* L. The type material is deposited in the South African Museum, Cape Town. This material was collected from strands of *Enteromorpha* sp.

Shell small, medium high and laterally compressed with a maxi-

mum diameter of 3 mm. The apex is directed to the left side. The pallial border of the shell is smooth. No ribbing is evident, but clearly defined lines of growth are visible. The external shell colour varies from rich brown to light brown and cream, usually with radiating brown stripes from the apex. Internally the shell is smooth with the brown radiating stripes showing through from the exterior. The adductor muscle impression is weakly marked. The siphon groove is not clearly distinguishable from the rest of the shell.

The gill is broadly U shaped. The posterior border of the kidney reaches to the posterior efferent vein from the gill. The gill does not, however, pass beyond the anterior efferent vein from the gill.

The genitalia has a small but distinct atrium formed by the fusion of the epiphallus duct, spermathecal and common duct. Near to the entry of the epiphallus duct there is a small, fusiform accessory organ (muscular sheath, HUBENDICK 1946). The epiphallus duct has a flagellum. The spermathecal duct is not swollen distally, and no clearly defined retractor muscle has been found. The radula formula is 15 : 1 : 15.

The foot is pale grey. The head lobes do not bear distinct eyes.

Distribution: Langebaan Lagoon, Saldhana Bay, West coast of South Africa.

Thus of the twelve species stated by HUBENDICK (1946) as occurring on the South African coast, only five are valid, and the remainder excepting *S. parvicostata* DESHAYES 1836, are reduced to the rank of synonyms. According to HUBENDICK (1946) this species is reported from Port Natal, South Africa. No further records have been made for this species notwithstanding the detailed biological survey work by EYRE & STEPHENSON (1938) and STEPHENSON *et al* (1937) on the Natal coast. This record therefore seems doubtful.

A KEY TO THE SOUTH AFRICAN SPECIES OF *Siphonaria*

- A. Shell normally symmetrical: ribs usually well marked and radially arranged. A distinct genital atrium. The kidney never extends in front of ant. eff. vein from gill Subgenus *Patellopsis*
 1. Spermathecal duct not swollen distally
 - i. Shell small to medium large; 37 to 47 weakly developed ribs. Genital atrium with a coarse retractor muscle proximally *S. capensis*
 - ii. Shell medium large to large; 24 to 27 well developed ribs, a number may fuse to form white sectors. White apical area within adductor muscle impression, may be restricted to a spot. Genital atrium without a coarse retractor muscle
S. deflexa

2. Spermathecal duct swollen distally

- iii. Shell medium large; 33—49 prominent ribs. Internally a white transverse bar. Genital atrium with a thin divided retractor muscle *S. oculus*
- iv. Shell medium large; 33—49 prominent ribs Area within adductor muscle impression orange brown. Genital atrium with two splayed retractor muscles *S. dayi*
- v. Shell small to medium large; 40—55 shallow ribs. Area within adductor impression brown. Externally apical area usually brown. Genital atrium with two splayed retractor muscles *S. anneae*
- vi. Shell small; 40—55 fine radiating ribs. Irregular lines of growth superimpose mottled appearance on shell. Internally slate blue. Genital atrium with two splayed retractor muscles *S. carbo*

- B. Shell symmetrical and very thin. The ribs are not clearly defined. The genital atrium bears a fusiform accessory organ without internal plication. Kidney never extends beyond ant. eff. vein from gill Subgenus *Sacculosiphonaria*
Shell small with no ribbing and laterally compressed
S. compressa

- C. Shell normally asymmetrical. Ribs well developed, often strongly protruding. Genital atrium bearing an accessory organ. Epiphallus duct thickened with connective tissue. Kidney extends in front of ant. eff. vein from gill Subgenus *Siphonaria*
Spermathecal duct not swollen distally and formed into loops.
Shell medium large to large, bearing spines. Two ribs form the siphon groove on right side *S. aspera*

3. DISTRIBUTION

Shore: The genus *Siphonaria* is widely distributed on the Southern coast of Africa, and is very common between False Bay and Um-pangazi. In the West, the distribution of the genus becomes less regular. *S. capensis* is present as far north as Port Nolloth; *S. aspera* occurs in a rather patchy manner from Cape Point northwards to St. Helena Bay and the Zout River. *S. oculus* and *S. deflexa* are very rare on the West coast. STEPHENSON (1947) states that *S. oculus* has not been found on the West coast during his survey of the intertidal fauna. He also says that *S. deflexa* is found on the West coast only at the southern end of the Cape Peninsula. However, one or two individuals of this species have been found in Table Bay at Green

Point. Thus it is safe to say that *S. oculus* and *S. deflexa* have virtually reached the end of their westward distribution in False Bay. Eastwards from False Bay *S. aspera*, *S. deflexa* and *S. capensis* are uniformly established to Umpangazi in Natal. *S. anneae* is reported from Isipingo, but not further South. Material received from the University of the Witwatersrand shows that this species extends at least to Inhaca Island, Delagoa Bay. *S. carbo* has been found at Inhaca, but this species is not represented in collections made further South and likewise *S. dayi*.

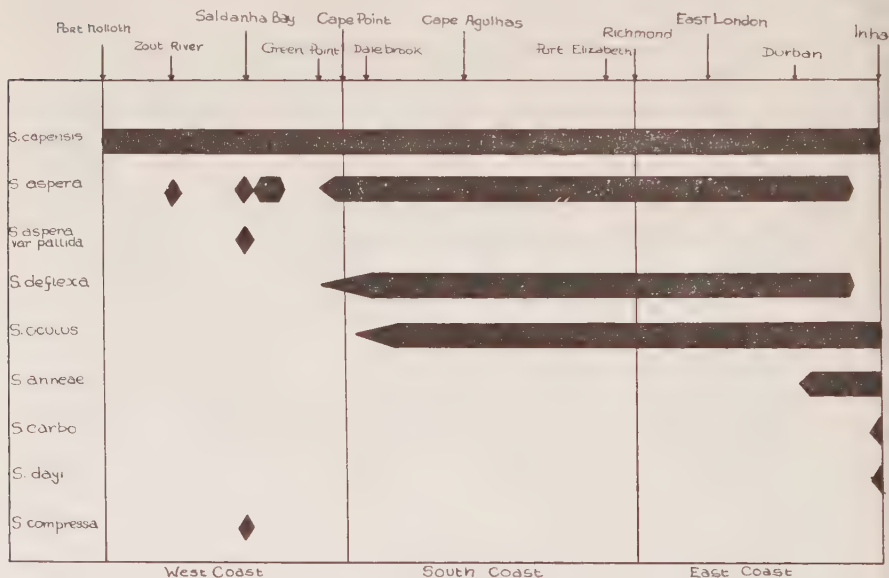


Fig. 19. A diagram showing the horizontal distribution of 9 species of *Siphonaria* around the coast of South Africa.

The distribution is shown in fig. 19 and the approximate localities of the stations where *Siphonaria* occur are shown in figure 20. Included in this figure are the mean annual surface sea temperatures for a number of years taken from ISAAC (1937).

The number of *Siphonaria* species increases from West to East. This increase is associated with a rise in sea temperatures around the South African coast. On the West coast the species are limited to three out of eight. *S. capensis* is common on the entire coast as also, though to a lesser degree, is *S. aspera*. *S. deflexa* and *S. oculus* occur in the temperate waters of the South and East coast and also extend into subtropical waters north of Durban. *S. carbo* and *S. dayi* are restricted to these subtropical waters.

These facts strongly suggest that the distribution of *Siphonaria* on the South African coast is related to coastal water temperature, and that the cold water of the West coast is a barrier to possibly less eurythermic species.



Fig. 20. A map of Southern Africa giving the approximate localities of stations where *Siphonaria* have been found

Estuaries: The estuaries in South Africa have been subject to detailed biological investigations by DAY (1952), SCOTT (1952) and MILLARD (1954). The work includes clear water estuaries with permanently open mouths and turbid water estuaries with almost permanently closed mouths. The investigations have included a study of both hydrographical conditions existing within the estuary and faunal changes occurring upwards from the sea. As a result the faunae of estuaries are divided into three components: marine, estuarine and typically fresh water. The *Siphonaria* species would therefore within an estuary compose part of the marine component.

Table II shows the frequency of *S. capensis*, *S. oculus*, *S. deflexa* and *S. aspera* in ten estuaries. *S. oculus* occurs in eight, *S. capensis* in six, *S. deflexa* and *S. aspera* in five. The number of species increases westwards. Bushmans River, Knysna, Great Brak River, Breede River and the Klein River possess all four species. While eastwards from Knysna, the species decrease in frequency until at St. Lucia only *S. oculus* is found, and at Richards Bay and Morrumbene, In-

hambane *Siphonaria* species are absent. The frequency of the species in the West coast estuaries is not known.

TABLE II

The occurrence of 4 species of *Siphonaria* in 10 South African estuaries.

Estuary	<i>S. oculus</i>	<i>S. capensis</i>	<i>S. deflexa</i>	<i>S. aspera</i>
Morrumbene,				
Inhambane	—	—	—	—
Richards Bay	—	—	—	—
St. Lucia	✓	—	—	—
Port Shepstone	✓	—	—	—
Keiskama	✓	✓	—	—
Bushmans R.	✓	✓	✓	✓
Knysna	✓	✓	✓	✓
Great Brak R.	✓	✓	✓	✓
Breede R.	✓	×	×	✓
Klein R.,				
Hermanus	×	×	×	✓

DAY *et al* (1952) have shown that the four faunistic divisions of Knysna estuary are determined by changes in wave action, salinity and substratum. Since *Siphonaria* species are not found on shifting muddy or sandy substrates the lateral zonation of these species in an estuary will depend on the extent of rock or similar firm substrate. Thus reduction in salinity need not necessarily act as a limiting factor. Sundays River estuary, for example, has no rock and the *Siphonaria* fauna is completely lacking. However, assuming a certain amount of rock at various points within an estuary, changes in salinity would become a limiting factor especially to marine species.

In Durban Bay, *S. oculus* is present in the Sanctuary area in salinities varying from 7 to 36 ‰ (J. H. DAY in press). In St. Lucia the same species occurs in the Point area which according to DAY *et al* (1954) was subject during 1950—51 to a salinity variation of 4.3 to 36.8 ‰. In Knysna *S. oculus* occurs in salinities of 28.4 and 8.8 ‰ (DAY *et al* 1952). In the Klein River estuary where *Siphonaria* species are found on rocks near the mouth SCOTT *et al* (1952) have shown considerable variation in salinity depending to a large extent upon the closure of the mouth during the summer months and dilution by rain during the winter. The values for salinities quoted are 12.59 to 39.04 ‰.

S. capensis appears to have much the same tolerance to salinity changes as *S. oculus* and according to DAY *et al* (1952) is to be found at Knysna on rocks in the Westerford bridge area where average low tide salinity is 8.8 ‰. Here *S. aspera* is also recorded but in the light

of as yet unpublished data obtained by the author on salinity tolerances of *S. aspera* this record seems highly improbable. Atypical forms of *S. oculus* are easily confused with *S. aspera* and it is noteworthy that in the preserved material from Knysna, only two *S. aspera* samples are recorded, and both of these were from nearer to the sea at Brenton Heads and Woodbourne where the average low-tide salinity is 31.5 ‰.

In general *S. oculus* and *S. capensis* penetrate furthest and *S. aspera* the least into estuaries. The reason for a westward increase in number of species inhabiting estuaries while on the shore there is an eastward increase in number of species is not known.

SUMMARY

A revision of the systematics of the genus *Siphonaria* found around the South African coast from Port Nolloth on the West coast to Inhaca Island on the East coast is given. Of the twelve species described by HUBENDICK (1946) as occurring on the South African coast only five are valid. The remainder are reduced to synonyms. Two new species and one new variety are described.

The horizontal distribution along the coastline of the valid species is described. Three species are recorded from the cold waters of the West coast while six species are recorded from the East coast. *S. deflexa* and *S. oculus* have a western distribution limit in False Bay. While *S. dayi* sp. nov. is only known from Inhaca Island. *S. anneae* and *S. carbo* occur in the subtropical waters near Durban. *S. capensis* and *S. aspera* are ubiquitous. *S. compressa* sp. nov. occurs only on the West coast in the sheltered waters of Langebaan lagoon, Saldanha Bay.

S. capensis, *S. oculus*, *S. deflexa* and *S. aspera* are all recorded from estuaries. The frequency increases westwards, while eastwards from Knysna the species decrease in frequency until at St. Lucia only *S. oculus* is to be found. *S. oculus* has been recorded where salinities vary between 4.3—36.8 ‰.

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Freshwater Algae of Sierra Leone

I. New and Unusual Algae from the Sula Hills

N. WOODHEAD & R. D. TWEED

(Department of Botany, University College of North Wales, Bangor)

The material collected by the late W. N. WOODHEAD whilst engaged on geological survey in the Sula Hills, lying in the north-east of the Protectorate of Sierra Leone, has yielded many taxa new to science. A description of the area and the nature of the collections has already been published (WOODHEAD & TWEED, 1956) in which brief reference has been made to the richness in freshwater algae for this area, so rarely visited. Here, we present diagnoses of the new taxa and a brief discussion of their systematic position. It is proposed to defer ecological discussion until a more comprehensive view has been taken covering collections made in other parts of Sierra Leone.

We are indebted to MR. & MRS. FITTON BROWN for their help in checking the Latin diagnoses, and to Mr. M. J. MAY for the sketch map. All the material is housed in the authors' algal herbarium collections at the University College of North Wales, Bangor, the appropriate number being appended after the initials „W. & T.” Size measurements have been given in the Latin diagnosis only, to save repetition of obvious criteria.

CHLOROPHYTA

Chaetophoraceae

PITHOPHORA WITTROCK 1877

P. tropica W. & T. *species nova*, Main filaments with branches of the first order only, the cells up to $100\ \mu$ long, sometimes capitellate. Akinetes intercalary, sometimes paired, either irregularly barrel-shaped or terminal and oval. (Fig. 93).

Rames solum ordinis primi, filamentis primis $14\ \mu$ latis, et ramis $6-8\ \mu$ latis; cellulae usque ad $100\ \mu$ longis, interdum capitellatis. Akinitis intercalatis interdum geminis, aut inaequaliter doliformis, $40-66\ \mu$ longis, $16.5-24\ \mu$ latis, aut terminalibus ovalibus $70\ \mu$ long., $33\ \mu$ lat.

Gerinka, summit of track at 2000 ft. (W. & T. 2073).

Desmidiaceae

CLOSTERIUM [NITZSCH 1817] RALFS 1848

C. rugosum W. & T. *species nova*, Cells six times longer than broad, of moderate curvature, the median part of the inner margin slightly inflated to give a flat portion, then gradually attenuate to the rounded apices. Cell wall distinctly and irregularly rugose so that the margins appear weakly crenate. Terminal vacuole with at least one granule. Zygosporoes not seen. (Fig. 17).



Cellulae 6-plo longiores quam latae, 91—105 μ long., 15.5—17 μ lat., curvatae modice in medio lateris ventralis leniter inflata plana tum attenuatis versus apices rotundatos; membrana valde et irregulariter rugosa marginibus cellularum tenuiter crenatis, locellis apicalibus corpuscula singula includentibus. Zygospora ignota.

River Kangofurina, (W. & T. 2229) in swamp.

Such a heavy granulation of the membrane is so unusual in the genus that W. & G. S. WEST (1904) did not include it as a possibility in their diagnosis; it is included, however, by IRENEE-MARIE (1938).

PLEUROTAENIUM NÄGELI 1849

P. gloriosum (TURN.) W. & G. S. WEST in SCHMIDT 1892, *forma sonfonense* W. & T. *forma nova*,

21 times longer than broad, the basal swelling the same width as the apex. One definite undulation above the basal swelling and a very shallow undulation above. Poles truncate, with 7 visible tubercles, flat but sharply defined, under their margins. Membrane very weakly punctate. (Fig. 47).

Forma cellulis minoribus et gracilioribus quam typus et *var. perlongum*. Cellulae 21-plo longiores quam latae, 387 μ long., 15.5 μ lat. in limbo, 18 μ lat. ad bas. semicellularum et etiam ad apices; semicellulis supra basin 1-undulato conspicue, et 1 undulato tenuissime, apicalibus truncatis, a fronte visis infra apices 7 tuberculis planis sed distinctis, membrana punctata delicatissime.

Lake Sonfon, (W. & T. 2241) on eastern bank.

Only half the size of *P. gloriosum* as described from Asiatic material, and smaller even than *var. perlongum* (W. & G. S. WEST) KR. in RABH. found in Singhalese paddy-fields. The elongated tubercles mark it off from *P. subcoronulatum* (TURN.) W. & G. S. WEST, with which it has affinities.

P. trabecula (EHR.) NÄG. 1849 *var. latior* W. & T. *var. nova*, only five times longer than broad, with a single basal inflation; cell membrane punctate, the apex quite without verrucae. (Fig. 18).

Var. solum 5-plo longior quam lata, 504 μ long., 95 μ flat. semicellulis ad basin solum 1-undulatis, apicibus totum sine verrucis, membrana punctata.

Tonkolili (W. & T. 2084).

The other varieties of *P. trabecula* are between 8 and 21 times longer than broad.

TRIPLOCERAS BAILEY 1851.

There had not been earlier records of this genus for any part of Africa.

T. gracile BAILEY 1851 *var. africana* W. & T. *var. nova*, close to *var. bidentatum* NORDST. but with the marginal thorns having 2

firm spines of different lengths, the upper (nearer the pole) always being the longer. Apex with 2 divergent arms, each with strong thick spines. Cell membrane bearing numerous whorls of simple spines which become stronger towards the centre of the desmid. (Figs. 5, 11.)

Var. *bidentatum* similis sed aculeis marginis spinulis firmis 2 longitudinis dissimilis, spinulo superiore semper longiore; apices processibus 2 divergentibus, cum spinis validis et crassis. Membrana cingulis multis spinulorum simplicium, in medio cellulae validiorum, 480—525.5 μ long., 33—35 μ lat. cum spinis, 45 μ lat. ad apic.

Lake Sonfon (W. & T. 2241) on eastern bank, with the following new variety:

T. gracile v. *torrida* W. & T. var. nova, close to var. *denticulatum* (PLAYF.) G. S. WEST but more slender than this Australian variety; spines usually thin and bristle-like. (Fig. 4). Var. *denticulatum* similis sed gracilior, 20-plo longior quam lata, aculeis fere angustis et setiformibus, 310 μ long., 15 μ lat., 17 μ lat. ad apic.

Lake Sonfon, (W. & T. 2241) with the preceding variety.

ICHTHYOCERCUS W. & G. S. WEST 1897

I. sierra-leonensis W. & T. species nova, a small squat species, the body dimensions only $1\frac{1}{2}$ times longer than broad. Semicells almost circular, with convex sides, 2 firm long spines marking off the convex apex which continues the arc of the semicell. Apical cell circular, with 2 long spines which do not lie diametrically opposite one another. Membrane moderately thick. (Fig. 1.)

Subparvus, habitu corporis breve atque obeso, diametro solum $1\frac{1}{2}$ -plo longiore quam latus; semicellulis a fronte visae fere rotundatae, lateribus convexis, apicibus etiam rotundatis cum spinis 2 longis et validis instructis. A vertice visae circulares cum spinis 2 longis non accurate adversis. Membrana modice crassa. 36 μ long. sine spinis, 70 μ cum spinis; 21 μ lat. sine spinis, 43 μ inter summas aculeorum; 10.6 μ lat. isth.

Lake Sonfon (W. & T. 2241), on the eastern bank. The genus was founded on material from Angola, and so far only includes the type species, *I. angolensis* W. & G. S. WEST with this new desmid.

EUASTRUM [EHRENBERG 1832] RALFS 1848

E. dubium NÄG. 1849 forma *africanum* W. & T. forma nova, smaller than the type, only $1\frac{1}{4}$ times longer than broad. (Fig. 24).

Parvior quam forma typica, paene $1\frac{1}{4}$ -plo longior quam lata, 23 μ long., 17 μ lat.

Near track between Gerinka and Sunkoni, south of the summit

nearest Gerinka, on greenstone (W. & T. 2078); also between the rivers Kansagbara and Mahoroni (W. & T. 2102).

E. obesum JOSHUA 1886 *var. minor* W. & T. *var. nova*, smaller than other known varieties, with a smooth cell membrane in contrast with the coarsely-punctate wall of *var. knysnanum* (HUB. PESI.) KR. in RABH., which comes closest to it in size. (Fig. 9).

Parvior a varietatibus notis aliis omnibus, 30—36 μ long., 17 μ lat., membrana glabra non punctata.

Tonkolili, (W. & T. 2083.)

E. platycerum REINSCH 1875 *var. decoratum* W. & T. *var. nova*, longer than the type, the proportions of length to breadth being 1.3—1.4/1, the sinus closed and linear. Protuberances on the face of the semicell with small teeth; two horizontal rows of puncta on the polar lobe. (Figs. 2, 19).

Var. longior, rationibus longa/lata = 1.3—1.4/1, sinu angustolineari, semicellulae in fronte visae projectiones denticulatis parvis, lobo polari seriebus 2 aequus punctorum. 59—64 μ long., 45—46 μ lat.

River Kangofurina swamp (W. & T. 2229) and stream (W. & T. 2239), a furlong apart.

E. pratense W. & T. *species nova*, with a narrow closed sinus, semicells trapeziform, the basal angles truncate, with a single tooth; upper lobes more or less straight, crenate with thickened membrane. Apex flat with a deep median incision, the polar lobes with a terminal thorn. Three smooth protuberances over the isthmus, and a single similar swelling under each polar lobe. Membrane smooth. Lateral view elongate-trapeziform with a large protuberance, the middle part strongly concave. Zygote unknown. (Figs. 3, 6).

Submediocre, circa $1\frac{1}{3}$ -plo longius quam latum, sinu angustolineari; semicellulae trapeziformes, angulis basalibus truncatis denticulo uno, lobis superioribus fere rectis, crenatis membrana incrassata, apicibus planis incisura profunda in medio, labis polaribus denticulo terminale. Membrana glabra, supra isthmum projectiones 3 leves et projectione simili infra lobum polarum utrumque. A latere visae elongato-trapeziformes cum projectione magna, in media parte valde concava, 48.6—60 μ long., 37—44 μ lat., 8.5—11 μ lat. isth.

Between the rivers Signakolo and Kildagarn in a grassy field, (W. & T. 2103).

This new species should be compared with *E. Crameri* RACIB. and its *variety tropicum* KRIEGER.

E. sinuosum [LENORM, 1845] ARCHER in PRITCHARD 1861 *var. africanum* W. & T. *var. nova*.

Small, about twice as long as broad, the polar lobe produced but not widened upwards, the lateral lobes pronounced as in the type. Protuberances arranged as in the type (Fig. 15).

Parvum, circiter duplo longius quam latum, $54\ \mu$ long., $27\ \mu$ lat. $10\ \mu$ lat. 15th., $11\ \mu$ lat. apic., lobis polaribus productis sed non ad apices divergentibus, lobis lateralibus conspicuis ut in typo. Projectionibus ut in typo.

Local, in three places near Gerinka, (W. & T 2074, 2078 & 2108)

The shape of this new variety differs from that of *var. reductum* (also found in the neighbourhood) in its proportions and in the nature of the margins of the lower lobes, whilst the polar lobe is not dilated in our new variety. From the type variety the proportions are likewise different, and the polar lobe has a different shape.

E. tonkoliliense W. & T. *species nova*, Small, about $1\frac{1}{2}$ times longer than broad, the sinus angular and gaping wide open. Semicells ovate-pyramidate, basal angles rectangular, acute and toothed, the sides shallowly concave to straight, upper angles acute and apiculate. Apex truncate or shallowly convex with a wide median incision; polar lobes with teeth at their angles. Small prominent granules at the corners of the basal and polar lobes within the edges, two smaller granules by the isthmus. Zygotes unknown. (Fig. 8).

Parvum, circiter $1\frac{1}{2}$ -plo longius quam latum, profunde constrictum sinu angulato extrorsum valde aperto. Semicellulae ovato-pyramidatae, angulis basalibus rectangularibus, acutis cum denticulatis, lateribus subconcavis vel rectis, angulis superioribus acutis et apiculatis, apicibus truncatis vel subconvexis, incisura lata in medio. Spina parva in angulis lobi polaris, granulis parvis sed prominentibus in angulis infra marginem loborum polarum et basalarum, granulis minoribus 2 prope isthmum, 34 — $34.5\ \mu$ long., 22.5 — $23\ \mu$ lat., 12.7 — $15.5\ \mu$ lat. apic., 6.8 — $7.5\ \mu$ lat. isth.

Waia, (W. & T. 2108).

More sharply angular than *E. elegans* and with different ornamentation.

MICRASTERIAS [AGARDH 1827] RALFS 1848

M. americana (EHR.) RALFS 1848 *var. hybrida* W. & T. *var. nova*, Smaller than the type, the membrane with rows of short thorns along each arm and along the median incision, but with at least 4 parallel rows on the polar lobe parallel to its flanks. (Fig. 25).

Var. parvior quam forma typica, 92 — $97\ \mu$ long., 79.5 — $88\ \mu$ lat., 36 — $40\ \mu$ lat. apic., 14.5 — $16\ \mu$ lat. isth., membrana seriebus denticulorum curtorum secundum processus et incisuras sed lobo

polari cum certe seriebus 4 parallelibus granulorum in parallelo marginibus.

In several localities, all collected from streams, Maranda (W. & T. 2029, 2030), between R. Signakolo and R. Kildagaran (W. & T. 2103), R. Chigara (W. & T. 2220) and R. Sende at its confluence with R. Funduburu (W. & T. 2234).

The shape and lobulation resembles that of the type variety though it has smaller dimensions; the ornamentation more closely resembles that of *M. mahabuleskwarensis* HOBSON. *M. americana* has been recorded from both East and Central Africa.

M. apiculata [(EHR.) MENEGH. 1840] RALFS 1848 *forma angustior* W. & T. *forma nova*, smaller and more slender than the type, 1.4—1.5 times longer than broad instead of as broad as long, the sinus closed. Polar lobe broad in relation to its length. 4 equal small spines at the apical corners, a group of 4 smaller spines in the middle of the retuse polar margins, and a single spine on each side. (Fig. 22).

Var. *parvior atque gracilior quam forma typica*, 1.4—1.5 -plo longior quam lata, 152—180 μ long., 107—125 μ lat., 50 u. crass. 58—66 μ lat. apic., 24 μ lat. isth., sinu occluso; lobo polari lato proportione longitudinis. Spinis 4 aequalibus et parvis in angulis apicalibus, in medio marginum retusorum apicis numero spinarum parviorum 4, utrobique una spina.

Mostly in streams, R. Chigara (W. & T. 2221), R. Kangofurina (W. & T. 2239 & 2232), and stream on the Kunya-Wesima track at 1450 ft. (W. & T. 2237). Later records in other parts of Sierra Leone indicate this slender graceful form has a wide distribution.

M. kangofurinensis W. & T. *species nova*, about $1\frac{1}{2}$ times longer than broad with an elliptical outline, deeply constricted in the middle, the sinus closed for most of its length but dilating outwards. Semicells 5-lobed, the polar lobe slightly exserted gradually widening upwards with concave sides. Apex convex, but retuse at its centre, its corners possessing a strong spine placed distantly from clusters of spines which spread to the middle. Lateral lobes sub-equal, bilobulate, the ultimate lobules markedly obtusely-rounded, their margins furnished with strong spines. Incisions between polar and upper lateral lobes narrow and closed. Cell membrane furnished with many spines, short but strong, in a line along each incision, scattered elsewhere, 4—5 granules on the median protuberance. Chromatophore axile and thick, occupying a quarter to a third of the cell thickness. (Fig. 29.)

Magna, circiter $1\frac{1}{2}$ -plo longior quam lata, cellula ellipticali profunde constricta sinu plerumque occluso, extrorsum ampliato, 158 μ long., 100 μ lat., 33. μ crass., 48 μ lat lob. pol. (max.), 33 μ lat. isth. Semicellulae 5-lobatae, lobis apicalibus leviter exsertis,

lateribus concavis gradatim divergentibus; apicibus convexis in medio retusis, angulis spino valido procul ab spinis ad medium attingentibus. Lobis lateralibus subaequalibus, bilobulatis, lobulis ultimis valde rotundatis, marginibus spinis validis praeditis. Incisuris inter lobos polares et laterales superiores angustis et oclulis. Membrana spinis multis, curtis sed validis, in serie secundum incisuram unamquemque sed ceteris dispersis, prominente medio cum granulis 4—5. Chromatophora axialis et crassa, quartam vel tertiam partem crassitudinis cellulae occupit.

R. Kangofurina (W. & T. 2239).

M. truncata (CORDA) BREB. ex RALFS 1848 *var. tridentata* BENN. 1890 *forma marandae* W. & T. *forma nova*, with cells longer than broad, the apices flat and slightly retuse in the middle; the uppermost lateral lobule of the third order alone possesses the 3 teeth characteristic of the variety, the remaining lobules bidentate. (Fig. 31).

Cellulae longiores quam latae, 100—119 μ long., 95—99 μ lat., apicibus planis in medio leviter retusis; lobulo summo laterale ordinis tertii solum dentibus 3, lobulis ceteris bidentatis.

Pool on red schists, Maranda (W. & T. 2028) and elsewhere in Sierra Leone.

COSMARIUM [CORDA 1834] RALFS 1848

C. decoratum W. & G. S. WEST 1895 *forma Kriegeri* W. & T. *nomen novum* is proposed for a form left unnamed in KRIEGER's lists for Indonesia (1932, pl. xii, fig. 16), his specimens being derived from Northern Sumatra and Java. We have found identical plants in streams at Maranda (W. & T. 2019 and 2025), 79 μ long, 61 μ wide with granulation as shown in KRIEGER's illustration.

C. gbuliense W. & T. *species nova*, Cells large, deeply constricted in the middle, the sinus acute and gaping widely open. Semicells widely elliptical, almost circular except at the apex, the sides and base rounded; apical view almost circular. Cell membrane scrobiculate, the arrangement being more or less parallel with the margins which, however, are smooth. Chromatophore axile, 5—7 rayed. Zygospore unknown. (Fig. 34).

Magnum, profunde constrictum, sinu acuto ample apetto. Semicellulae late ellipticae fere orbiculares sed non in apicibus, lateribus basalibusque rotundatis; a vertice visae fere circulares. Membrana marginibus glabris, ceteris scrobiculatis in seriebus parallelibus cum marginibus. Chromatophora axiali, 5—7 radiata. 99—102 μ long., 70—71 μ lat., 65—66 μ crass., 15—28 μ lat. isth.

Gbulia, at highest part of the track to Sakasakala (W. & T. 2106).

C. kangofurinense W. & T., *species nova*, Large, about $2\frac{1}{2}$ times longer than broad with deep median constriction, the sinus narrowly linear, rounded, obtuse within and ampliate outwards. Semicells pyramideate, the angles rounded, sides convex and apex broadly truncate. Membrane uniformly verrucose in horizontal and oblique series, each verruca surrounded by 3 small puncta. The lateral edges of the semicell appear heavily beaded, but the apex is somewhat smooth. (Fig. 33).

Magnum, circiter $2\frac{1}{2}$ -plo longius quam latum profunde constrictum sinu anguste lineari extremo rotundato obtusatoque infra extrorsum ampliato. Semicellulae pyramidatae angulis rotundatis, lateribus convexis, apicibus late truncatis. Verrucis membrana in tota oblecta, verrucis in seriebus obliquis et horizontalibus punctis parvis 3 circa verrucam singulam. Marginibus lateralibus valde margaritatis sed apicibus fere glabris. $125\ \mu$ long., $50\ \mu$ lat., $19\ \mu$ lat. isth.

River Kangofurina swamp. (W. & T. 2229).

Stands near *C. multiridatum* W. & G. S. WEST, which has been found in Angola and Victoria Nyanza, and *C. subbalteum* SCHMIDLE, another East African species. It is larger than them and has a much heavier ornamentation.

C. minor (TURN.) GUTW. 1902 *f. minor* W. & T. *forma nova*, smaller than the type. (Fig. 30).

Forma cellulis minoribus, $23.5\ \mu$ long., $27-29.5\ \mu$ lat. Pool near summit of track from Gbulia to Sakasakala (W. & T. 2126).

C. pseudobaronii W. & T. *species nova*, Large, about 1.4 times longer than broad with a deep median constriction, the sinus very narrowly linear, ampliate outwards. Semicells subglobose, the base wide and straight, sides and apex evenly convex. Membrane covered with concentric series of granules which become progressively smaller from the margins inwards, with irregular hexagons of scrobiculations around the granules; these hexagons are less conspicuous near the margins than at the centre. (Fig. 36).

Magnum, circiter 1.4-plo longius quam latum, profunde constrictum sinu angustissime lineari extrorsum ampliato. Semicellulae subglobose, basalibus rectis atque latis, lateribus et apicibus aequaliter convexis. Membrana seriebus concentricorum granulorum, granulis seriei exterioris maioribus, scrobiculis circa granulos in forma hexagonalis inaequalis ordinatis. $144\ \mu$ long., $100\ \mu$ lat.

River Kangofurina (W. & T. 2239).

Differs from *C. Baronii* W. & G. S. WEST in its shape, but its ornamentation closely resembles that of the handsome Malagasy desmid; it has affinities with the New Zealand *C. magnificentum* NORDST.

C. punctulatum BREB. 1856 forma *Welwitschii* W. & T. nomen novum. We propose this name to include the smallest plants described for *C. punctulatum* in the WELWITSCH gatherings from Angola (W. & G. S. WEST, 1897, pg. 121), which are half the size of the customary plants. Our plants from the River Signakolo (W. & T. 2103) and the River Makalankala (W. & T. 2228) correspond, measuring 17—19 μ long as against 18 μ long, 18 μ wide for Angola. The isthmus is narrow, the sinus very narrow, opening at the outer end. The apex is flat and granulate, the granules being acute.

C. sierra-leonense W. & T. species nova, Large, 1.2 times longer than broad with a shallow median constriction, the sinus being represented by an obtuse channel, widely open. Semicells broadly elliptical with strongly-convex sides arising from a straight base, the apex subtruncate. Membrane thick with large rounded granules arranged in 8 oblique and from 8 to 10 horizontal rows, each granule surrounded by small puncta in decussate series. A narrow zone on each side the isthmus remains free from ornament. Apical view circular. The material has yielded two size forms which do not overlap. (Fig. 32).

Magnum, 1.2-plo longius quam latum, lenissime constrictum sinu amplo aperto simili modo sulco obtuso. Semicellulae late ellipticae, marginibus valde convexis, basalibus rectis, apicibus subtruncatis. Membranacrassa granulis magnis rotundatisque in seriebus obliquis 8 et aequis 8—10 ordinatis, punctis parvis in seriebus decussatis circa granulum, ad basin semicellularum glabra. A vertice visae circulares. Forma maior 100.5—135.5 μ long., 68—74 μ lat., 32—43 μ lat. isth. Forma minor 82.5—90.5 μ long., 59—61 μ lat., 30—40.2 μ lat. isth.

In grassy field between R. Kansagbara and R. Maharoni (W. & T. 2102).

C. Stansfieldii W. & T. species nova, Small, about $1\frac{1}{4}$ to $1\frac{1}{2}$ times as long as broad with deep median constriction, the sinus narrowly linear. Semicells trapeziform with convex sides and truncate apex, all angles rounded. Margins of the sides with 4—6 strong granules, obtusely-conical, the membrane with 2 horizontal rows of granules arranged 4 above the base and 3 slightly above the centre, 2 smaller granules within each basal angle. Rest of the membrane punctate, more delicately so towards the centre. In side view the semicell is circular with a thick membrane showing verrucose granules on the margins, and 2 parallel rows of granules extending from apex to apex. The vertical view is elliptical with verrucose granules on the sides and apices; a ring of smaller granules in the centre. Two pyrenoids in each semicell. (Fig. 39).

Parvum, circiter $1\frac{1}{4}$ — $1\frac{1}{2}$ -plo longius quam latum, profunde constrict-

tum sinu anguste lineari. Semicellulae trapeziformes lateribus convexis, apicibus truncatis, angulis omnibus rotundatis. Marginibus laterum cum granulis 4—6 validis, obtuse conicis. Membrana cum seriebus 2 horizontalibus granulorum, 4 supra basin, 3 paulo supra centrum semicellularum ornata; intra marginem apicalem cum granulis minoribus 2, et intra angulam basalem quemque granula parva, membrana semicellularum cetera punctata, ad centrum punctis delicatioribus. A latere visae semicellulae circulares, membrana crassa marginibus verrucoso-granulosis, et seriebus parallelis 2 granulorum ex apice ad apicem; a vertice visae ellipticae lateribus apicibusque verrucoso-granulosis, in medio cum annulo granulorum minorum. Pyrenoidibus in utraque semicellula 2. 43—56 μ long., 38—43.5 μ lat., 30 μ crass., 10 μ lat. isth.

Gerinka (W. & T. 2074); near R. Signakolo (W. & T. 2103) and a pool at the summit of the Gbulia to Sakakasala track, laterite on greenstone (W. & T. 2106).

This new species, the epithet of which is a family name of the collector, should be compared with *C. taxichondrum* LUND.

C. subauriculatum W. & G. S. WEST 1895 var. *duplo-major* W. & T. var. *nova*, about double the size of the type. (Fig. 16).

Paene duplo-maius, 86.9—92 μ long, 74.1—78 μ lat. 25.4 μ lat. isth., membrana 2 μ crassa.

Confluence of the rivers Sendé and Funduburu (W. & T. 2234).

C. succisum W. WEST 1892 forma *Jaoi* W. & T. *nomen novum*, our plants are identical with an unnamed form in JAO's description (1949) of Kwangsi desmids, 12 μ long, 12 μ wide. We propose to name the form in honour of the original discoverer of this tiny desmid, now known in China and West Africa. In the River Makoke, Maranda (W. & T. 2019).

XANTHIDIUM [EHRENBURG 1834] RALFS 1848

X. pseudoraciborskii W. & T. *species nova*, of medium size, a little longer than broad, the sinus narrowly linear, acute within and ampliate at the outer extremity. Semicells sub-pyramidate, the sides almost straight or very gently concave, the apices truncate and straight. Basal angles sharply rounded, the apical corners angular, all angles with 3 acute short spines. Membrane strongly punctate in oblique series, mostly parallel with the flanks of the semicell. Apical view rhomboid with 3 well-marked spines at the poles. Chromatophores with 2 pyrenoids.

Mediocre paulum longius quam latum, profunde constrictum

sinu anguste-lineari apice acuto extremo ampliato. Semicellulae subpyramidatae, lateribus fere rectis vel lenissime concavis, apicibus truncatis et rectis; angulis inferioribus acutorotundatis, angulis superioribus acutis, angulis omnibus spinis acutis et curtis 3 praeditis. Membrana valde punctata, punctis saepe in parallele cum marginibus semicellularum in seriebus obliquis. A vertice visae rhomboidalis in apicibus cum spinis 2 conspicuis. Pyrenoidibus in utraque semicellula 2. 50—61 μ long., 42—48.6 μ lat., 40 μ crass., 21 μ lat. isth.

Kagleguma, stream on greenstone with migmatite (W. & T. 2076), Gerinka to Sunkoni track, pool on greenstone (W. & T. 2078), between the rivers Kandagbara and Maharoni (W. & T. 2102), between the rivers Signakolo and Kildagaran (W. & T. 2103) and two pools between the rivers R. Kansagbara and Tonkolili east of Gbulia (W. & T., 2108 and 2109).

In many specimens one of the two semicells lacks the distinctive spines. This new species is not uncommon; it has a close relationship, as the epithet implies, with *X. Raciborskii* GUTW. from which it is readily recognised by its greater angularity. It also has some similarities with *X. Raciborskii* var. *glabrum* JAO.

X. sonfonense W. & T. *species nova*, small, with deep median constriction, the sinus linear, obtuse within, the extremities dilated. Semicells broadly pyramidal-truncate, the angles sharply rounded, the sides slightly convex and the apex wide and straight. Two short spines at each angle; membrane delicately punctate. Side view of semicell circular, the apical view elliptical with 3 spines visible at the poles. (Fig. 7).

Parvum, profunde constrictum sinu lineari apice obtuso extrorsum dilatato. Semicellulae late pyramidal-truncatae, angulis acutorotundatis, marginibus leniter convexis, apicibus latis et rectis; angulis omnibus spinis acutis et curtis 2 praeditis, membrana subtiliter punctata. A latere visae circulares, a vertice visae ellipsoidales in polis cum spinis 3. 40—44.2 μ long. cum spinis, 38—44.2 μ lat., 12.7—18 μ lat. isth.

Lake Sonfon (W. & T. 2241).

This *Xanthidium* has a remarkable similarity with the front view of *Cosmarium margaritaceum* were it not for the distinct appearance of its spines. It may be compared with *X. Raciborskii*.

STAURASTRUM [MEYEN 1829] RALFS 1848.

S. africanum W. & T. *species nova*, small with a deep median constriction, the sinus acute within and gaping widely outwards. Semicells broadly elliptical, the sides distinctly convex but the apex

less convex. All the angles rounded and furnished with 3 spines, more or less distantly placed. Cell membrane smooth, Apical view triangular, the sides convex and the corners rounded, each furnished with 3 spines. Chromatophore axile with radiating lobes. (Fig. 31a).

Parvum, distincte constrictum sinu acuto ample aperto. Semicellulae late ellipticae, lateribus convexis, apicibus minus convexis; angulis omnibus rotundatis cum spinis 3 plus minusve distantibus munitis. Membrana glabra. A vertice visae triangulares lateribus convexis, angulis cum spinis 3 rotundatis. Chromatophora axiali lobatis radiatis. 29—30 μ long., 21—22 μ lat., circa 20 μ crass.

Gerinka (W. & T. 2074).

S. gerinkae W. & T. *species nova*, small, $1\frac{1}{5}$ times longer than broad, slightly constricted in the middle, the sinus represented by a small obtuse furrow. Semicells obversely triangular, wider at the apex than the base, the sides very slightly convex and the apex slightly retuse. Each basal angle furnished with a tooth, the apical angles rounded. In vertical view quadrate with strongly concave sides and rounded corners. Membrane regularly punctate. (Fig. 13).

Parvum, $1\frac{1}{5}$ -plo longius quam latum, leniter constrictum, sinu obtuso atque sulcatoformi. Semicellulae ob-triangulares, apicibus latoribus quam basis, leniter retusis, lateribus lenissime convexis. In angulo basali quemque dente, angulis apicalibus rotundatis. A vertice visae quadratae lateribus valde concavis et angulis rotundatis. Membrana regulariter punctata. 18—19 μ long., 14—15 μ lat., 9 μ lat. isth.

On haematite, Gerinka at 2000 ft., (W. & T. 2073), the locality thus having a high iron content. The species is close to *S. Meriani* REINSCH but its proportions are different and the apical view quadrangular.

S. sonfonense W. & T. *species nova*, of medium size, $1\frac{1}{3}$ — $1\frac{1}{2}$ times longer than broad, with a deep median constriction, the sinus opening widely and acutely. Semicells sub-elliptical, the apex concave, the lateral margins convex. Angles produced and provided with 2 strong but thin spines of varying lengths, projecting obliquely outwards and upwards, lying in the same vertical plane parallel to one another. Vertical view triangular. Cell membrane smooth. (Fig. 45).

Mediocre $1\frac{1}{3}$ - $1\frac{1}{2}$ -plo longius quam latum profunde constrictum sinu acuto ample aperto. Semicellulae sub-ellipticae apicibus concavis, marginibus lateralibus convexis, angulis productis et divergentibus sed in visa una parallelibus, spinis 2-magnitudinis dissimilis, robustis sed gracilibus. A vertice visae triangulares. Membrana glabra. 50.8—70 μ long., 34—56 μ lat., 17—30 μ crass., 13—14 μ lat. isth.

Lake Sonfon (W. & T. 2241).

Stands near *S. longispinum* (BAILEY) ARCHER, which is larger and has much stouter spines; the shape of the semicell is different.

PHYMATODOCIS NORDSTEDT 1877.

P. irregulare SCHMIDLE 1898 *forma sonfonense* W. & T. *forma nova*, Cells straight-sided and united along most of their length as in *P. Nordstedtianum* WOLLE, irregularly quadrate and tuberculate. The degree of median incision has been difficult to assess as considerable disarticulation of the vegetative filaments had taken place prior to conjugation. In apical view trapeziform with all 4 sides concave, the curvature much deeper on one of the shorter sides than the rest. Zygosporis very large and rectangular, the corners markedly concave, occupying all the space between the conjugating filaments and most of the cell width as well. The spore wall consists of a colourless episporis, a deep yellow smooth mesosporis and a colourless endosporis. (Fig. 43).

Cellulae lateribus rectis et fere in longo coniunctis ut *P. Nordstedtianum* irregulariter quadratae et tuberculatae, filis leniter tortis, 16—30 μ long., 32—40 μ lat. A vertice visae trapeziformes, lateribus omnibus concavis sed latere uno in ambitu plus rotundato, hic 20 μ lat., 35—40 μ crass. Zygosporis magnis rectangularibusque paene cellulas complentibus, angulis valde concavis, 45—50 μ long., 64—65 μ lat., membrana 6—7 μ crass., epispora hyalina, mesospora fuscolutea atque glabra, endospora hyalina.

Lake Sonfon (W. & T. 2241).

Up to now zygosporis for any form of *P. irregulare* have been unknown, and the character of their corners in this West African material does not fit the diagnosis given for generic characters („abgestumpfen”). The new form has vegetative dimensions less than previously-described material of the species.

CHRYSOPHYTA

Chrysophyceae

MALLOMONAS PERTY 1852.

M. glabra W. & T. *species nova*, Cells elliptical with a very short collar at the anterior end, this collar having extremely minute teeth. Cells thrice as long as broad, almost hyaline and very weakly silicified, the scales rhomboidal-imbricate. Flagellum long. Neither setae nor spines present. (Fig. 10).

Cellulae 3-plo longiores quam latae, ellipticae ad partem anteriorem cum collo brevi dentibus delicatissimis minuto. Membrana

lenissime silificis fere hyalina, squamulis rhomboido-imbricatis nec setis nec aculeis. Flagello longo. Cellulae $18\ \mu$ long., $6\ \mu$ diam.

Lake Sonfon, west bank near Dalakuru (W. & T. 2235 & 2236). The species should be compared with *M. anglica* (N. CARTER) HUB.-PEST.

M. sonfonensis W. & T. *species nova*, Cells fusiform, nearly thrice as long as broad and suddenly tapered to a short spine at the posterior end, the other end with a short narrow collar flared open at its extremity. Scales transversely elongate, rhomboidal and in regular imbricate rows. (Fig. 20).

Cellulae fere 3-plo longiores quam latae, fusiformes ad apicem posteriorem subito ad aculeam curtam attenuatae, ad anteriorem cum collo breve atque angusto, summo dilatato, $21\ \mu$ long. cum acul., $7.7\ \mu$ lat. Squamulis transverse elongatis rhomboidalibus circiter $2\ \mu$ long., $3.5\ \mu$ lat., in seriebus imbricatis et regularibus.

Also in Lake Sonfon (W. & T. 2235).

We place this species in the sub-group *Quadratae*.

BACILLARIOPHYTA (PENNALES)

Fragilariaceae

FRAGILARIA LYNGBYE 1819

F. strangulata (ZANON) HUST. *forma constricta* W. & T. *forma nova*, Frustules linear, the ends rounded-capitate and abstricted, sides concave so that the middle part is constricted. Striae 10—12 in $10\ \mu$, the teeth about 5—6 in $10\ \mu$. (Fig. 70).

Valvae lineares in medio constrictae apicibus rotundato- et abstrictis lateribus concavis 43.5 — $75\ \mu$ long 3.8 — $5.0\ \mu$ lat. Striis transapicalibus 10—12 in $10\ \mu$, dentibus circiter 5—6.

With the type in a pool at Maranda (W. & T. 2028).

Eunotiaceae.

EUNOTIA EHRENBERG 1837.

E. chigara W. & T. *species nova*, valve with the margins almost parallel, the ventral side gently concave with the ends evenly rounded. Raphe short, directed away from the poles at the ventral corners. Transapical striae with minute teeth regularly disposed close to the dorsal margin; pseudoraphe also close to the ventral margin (Fig. 59).

Valvae marginibus fere parallelis, margine ventrali leniter concavo, apicibus regulariter rotundatis, 78.5 — $85\ \mu$ long., 6.3 — $8.4\ \mu$ lat.

Rhaphe brevis in angulis ventralibus ab polaribus deviata. Striis transapicalibus 18—20 in $10\ \mu$ cum denticulis perminutis, circiter 7 in $10\ \mu$ regulariter positae ad marginem dorsalem approximatis: pseudorhaphe ad marginem dorsalem approximata.

River Chigara (W. & T. 2221).

This distinctive new species belongs to the series transferred by HUSTEDT (1949) from EHRENBURG's genus *Desmogonium* and should be compared with *E. lineolata* which was also present in this gathering.

E. Zanonii W. & T. *species nova*. Ventral side concave, the dorsal side weakly undulate and convex, the ends obtusely rounded but neither produced nor capitate. Raphe at the poles rises to about a third of the width of the valve surface. Pseudoraphe indistinct. Transapical striae parallel, very fine and close. (Fig. 62).

Valvae margine ventrali concava, margine dorsali convexa et leniter undulata, apicibus obtuse-rotundatis nec productis nec capitatis, $25.5\ \mu$ long., $3.8\ \mu$ lat. Raphe prope polos ad tertiam partem superficiei sitae, pseudorhaphe non distincta. Striis transapicalibus circiter 30 in $10\ \mu$ subtilissimis et densissimis, parallelis.

River Chigara, (W. & T. 2221).

We have named this in honour of DR. V. ZANON. The species has affinities with forms of *E. Grunowii* as depicted by BERG, but the striation is unusually dense and delicate for *Eunotia* species.

Achnanthaceae

ACHNANTHES BORY ST. VINCENT 1822.

A. africana W. & T. *species nova*, Valves elliptical, the apices evenly rounded. Raphe valve with a straight raphe, a narrow axial area with the central area a transverse fascia reaching the margins, striae parallel, distinctly punctate in longitudinal rows. Raphe-less valve with the axial area narrow, linear lanceolate, the central area being a narrow transverse fascia, striae parallel and not visibly punctate. (Fig. 57).

Valvae ellipticae apicibus aequaliter rotundatis, 17.5 — $19.5\ \mu$. long., 6 — $7\ \mu$ lat. Rraphevalva raphe recta, area axiali angusta, area centrali fasciam usque ad marginem percurrentem formante, striis transapicalibus parallelis circiter 18 in $10\ \mu$, distincte punctatis in seriebus longitudinalibus etiam 18 in $10\ \mu$. Areovalva area axiali angusta lineari-lanceolata, area centrali in fasciam transversam angustam dilatata, striis transapicalibus parallelis sed non punctata, circiter 18 in $10\ \mu$.

Sunkoni, small stream on greenstone (W. & T. 2077) and R. Tonkolili (W. & T. 2080).

Distinctive within the genus, superficially like an *Anomoeoneis*.

A. maranda W. & T. *species nova*, Linear-lanceolate, the sides convex with rounded poles. Raphe valve with a very delicate filiform raphe, a very narrow axial area broadening suddenly to a transverse fascia which reaches the margin. Striae very close and delicate, vaguely radial, over 30 in $10\ \mu$, one shorter stria on each side in the middle of the transverse fascia. Raphe-less valve with a moderate axial area likewise widening into a transverse fascia which lacks short striae, otherwise the striation corresponds with that on the raphe valve.

Valvae lineari-lanceolatae marginibus convexis apicibus rotundatis, $1915\ \mu$ long., $2.8\ \mu$ lat. Rhaphevalva raphe filiforma atque delicatissima, area axiali angustissima subito dilatata fasciam usque ad marginem percurrentem formante; striis transapicalibus confertissimis et subtilibus, 30 in $10\ \mu$, stria breviorque utrobique in media parte fasciae. Areovalva area axiali moderata etiam fasciam sine striis brevibus formante; striis alioqui raphevalva similibus sunt.

Stream at Maranda (W. & T. 2019)

Naviculaceae

NAVICULA BORY ST. VINCENT 1822

N. submuticoides W. & T. *species nova*, *Minusculae*, small, broadly elliptical with the ends evenly and broadly rounded. Raphe filiform with the central pores turned the same way: axial area very narrowly linear, the central area a central band with a streak-like pore on one side the central nodule, easily distinguished from the striae. Striae almost perpendicular to the axial line and parallel with a slightly decussate punctuation. (Fig. 92).

Minusculae, parva, cellulae ellipticae apicibus aequaliter lateque rotundatis, $13\ \mu$ long., $7.5\ \mu$ lat. Rhaphe filiforma, foraminibus centralibus in eandem directionem recurvatis, area centrali in fasciam dilatata cum poro lineiformi in uno latere ab striis distinguendo, area axiali angustissime lineari. Striis transapicalibus fere ad lineam mediam perpendicularibus, parallelibus circiter 30 in $10\ \mu$, punctis leviter decussatis.

R. Chigara (W. & T. 2220).

Stands close to *N. muticoides* HUST. but separated from this Central African species by the form of the central area and the inclination of the striae.

N. subtilissima CLEVE *forma rostrata* W. & T. *forma nova*, Poles rostrate, not capitate, valves slender and longer than in the type. (Fig. 80).

Apicibus rostratis non capitatis, valva angusta longior quam typum, $36.5\ \mu$ long., $3.5\ \mu$ lat.

Frequent in Lake Sonfon (W. & T. 2241).

A larger diatom than *N. pseudosubtilissima* MANG. in BOURR. & MANG. 1952; it could equally be regarded as a large variety of *N. bryophila* PETERSEN.

N. sunkonensis W. & T. *species nova*, *Lineolatae* with elliptic-lanceolate valves having produced ends, the poles obtusely rounded. Raphe straight, filiform; axial area linear of moderate width, interrupted in the middle by the 2 median striae being longer than the rest (a striking reversal of the usual arrangement), so that there is no clearly-defined central area. Other striae radial, becoming convergent near the poles. (Fig. 78).

Lineolatae, valvae elliptice-lanceolatae apicibus productis polaribus obtuso-rotundatis, $23.3\ \mu$ long., $7\ \mu$ lat. Rhaphe recta atque filiforma. Area axiali lineari moderate lata, in medio striis longioribus 2 interrupta sine area centrali; striis ceteris radiatis, 14 in $10\ \mu$, versus apices convergentibus.

Rice-field at Sunkoni (W. & T. 2075).

This distinctive small diatom has affinities with the *N. placentula* series.

PINNULARIA EHRENBURG 1840.

P. Millsii W. & T. *species nova*. *Tabellariae*, large, broadly linear with obtusely-rounded apices. Raphe almost straight with large comma-like polar spaces: central pores are turned the same way. Axial area wide and linear, central area distinct as a transverse fascia reaching the margins where there are occasional isolated striae. Three pores placed on one side the central nodule in the fascia. Ribs radial in the middle becoming slightly convergent towards the ends and crossed by a broad longitudinal band. (Fig. 82).

Tabellariae, magna, cellulae late lineares apicibus obtusorotundatis, 170 — $173\ \mu$ long., 35 — $38\ \mu$ lat. Rhaphe fere recta fissuris polaribus magnis commaformibus, poris centralibus in eandem directionem recurvatis; area axiali lata et lineari, area centrali fasciam transversam usque ad marginem percurrentem formante, aliquando striis sparsis, et semper uno latere cum poris 3. Costis in medio radiantibus prope polos leniter convergentibus, 5 — 6 in $10\ \mu$, stria longitudinale lata transversis.

R. Chigara (W. & T. 2221).

This handsome species should be compared with *P. valida* HUST., which, however, is smaller and has a different organisation of its

striae. We dedicate this species in honour of the late F. W. MILLS, Esq., whose studies included diatoms from West Africa.

P. pseudobrandelii W. & T. *species nova*, *Tabellariae*, large, linear and slightly inflated in the middle but not undulate, the ends broadly rounded. Axial area of moderate width, linear becoming slightly lanceolate towards the middle; central area a transverse fascia with a shallow lunate mark on each side of the central nodule. Transapical striae radial in the middle, convergent at the ends, 11 in $10\ \mu$. (Fig. 79).

Tabellariae, magna, valae lineares in medio leniter inflatae non undulatae, apicibus late rotundatis, $190.8\ \mu$ long., $34.5\ \mu$ lat. Area axiali modice lata, lineari ad mediam leniter lanceolata, area centrali fasciam transversam usque ad marginem percurrentem formante, utroque signo lunato. Striis transapicalibus 11 in $10\ \mu$ in medio radiantibus ad apices convergentibus.

Rice-field at Gbulia (W. & T. 2104).

Distinguished from *P. Brandelii* CLEVE and *P. stomatophora* (GRUN.) CLEVE by reasons of size and shape of the frustules, from the former by the widths of the areas.

P. seliana W. & T. *species nova*, *Parallelistriatae*, the valve narrowly linear with the middle part shortly inflated and the ends broadly rounded. Axial area narrow, central area a broad transverse fascia reaching the margins. Transapical striae radial throughout (Fig. 81).

Parallelistriatae, valvae anguste lineares in medio breviter inflatae apicibus late rotundatis, $39\ \mu$ long., $5.5\ \mu$ lat. Area axiali angusta, area centrali fasciam transversam usque ad marginem percurrentem formante. Striis transapicalibus 12—14 in $10\ \mu$ omnino radiantibus.

Tributary of R. Seli, (W. & T. 2100).

We place this species near *P. leptosoma* (GRUN.) CLEVE from which it is readily distinguished by its tumid centre.

P. sierra-leonensis W. & T. *species nova* (*Tabellariae*), valves large, linear-lanceolate and noticeably inflated at the poles and in the middle, yielding subcapitate-rounded ends. Axial area moderately wide and distinctly punctate, somewhat lanceolate, widening in the middle to a transverse fascia constituting the central area; two arched rows of pores on each side the central nodule. Raphe filiform and straight, the central pores close together, curving the same way. Transapical striae strong, radially curved in the middle, convergent at the ends, punctate. (Fig. 76).

Tabellariae, Magnae, valvae lineari-lanceolatae in polis et in medio valde inflatae, apicibus subcapitato-rotundatis, $193.5\ \mu$ long., $22.5\ \mu$

lat. Area axiali modice lata, distincte punctata aliquatenus lanceolata cum area centrali in fasciam dilatata; utrobique nodulum centalem seriebus 2 curvatis pororum. Rraphe recta, filiformis, poris centralibus approximatis et in eandem directionem recurvatis. Striis transapicalibus robustis in media parte curvatis et radiantibus, prope polos convergentibus, 9 in 10 μ punctatis.

Lake Sonfon, (W. & T. 2241).

Differs from *P. gibba* EHR. in its punctate axial area and the curious lines of pores in the transverse band; two such series have not been described before for any *Pinnularia*. This feature and also the proportions of the axial area, together with the size, distinguish the new species from *P. acrosphaeria* (BREB.) W. SMITH.

P. Smithii W. & T. *forma subparallela* W. & T. *forma nova*, differs from *f. minor* W. & T. in that the sides of the valve are almost parallel and the ends are remarkably capitate (6.5 μ across). Fig. 63).

Differs from *f. minor* W. & T. marginibus fere parallelibus et apicibus valde capitatis (6.5 μ lat.), valvis 36.5—54 μ long., 4—5 μ lat.

River Kangofurina (W. & T. 2239).

P. sonfonensis W. & T. *species nova*, *Maiores*, valves large, linear and slightly inflated in the middle, the ends broadly rounded. Axial area wide, lanceolate, occupying about a third of the valve width but constricted sharply near the polar nodules and then widening to rounded polar nodules, all clearly punctate. Central area represented by a very gentle widening of the axial area. Raphe straight, the central pores close together, the terminal fissures uncinat. Transapical striae almost perpendicular to the raphe throughout. (Fig. 84).

Maiores; magnæ, valvae lineares in medio leniter inflatae, apicibus late rotundatis, 228 μ long., 41 μ lat. Area axiali lata lanceolata, tertiam partem amplitudinis valvae tenente sed ad fissuras polares subito constricta tum ad nodulos terminales rotundatos dilatata, omnino punctata. Area centrali solum paulo dilatata. Rraphe recta poris centralibus approximatis, fissuris terminalibus uncinatis. Striis transapicalibus fere ad lineam mediam perpendicularibus, 6—7 in 10 μ .

Lake Sonfon (W. & T. 2241).

This species shows some agreement with *P. guineensis* ZANON but it is much larger and has a different striation.

CYMBELLA AGARDH 1830.

C. calida W. & T. *species nova*, Valves linear-lanceolate, slightly asymmetrical, gradually tapering to acute ends. Raphe straight; axial area narrow slightly dilated in the middle to form a circular central area. All the transapical striae are radial, the median shorter

than the rest, with an isolated punctum on one side in the central area. (Fig. 69).

Valvae lineari-lanceolatae paulo asymmetricae ad apices acutos gradatim attenuatae, 46.5—51.2 μ long., 5.6 μ lat. Rhaps recta, area axiali angusta in medio dilatata; area centralis circularis. Striis transapicalibus radiantibus mediana brevior, 11 in 10 μ , in uno latere areae cum puncta singulo.

Lake Sonfon, (W. & T. 2241).

Somewhat like *C. borealis* CLEVE but smaller with pointed ends and has the isolated punctum as distinguishing characters.

C. hybrida GRUN. in CLEVE & MÖLLER var. *sierra-leonensis* W. & T var. *nova*, wider than the type, and the striae more radial in the centre. (Fig. 68).

Differt a typo latiore, 49—52.5 μ long., 12—14 μ lat.: striis transapicalibus in medio radiantioribus, 11—12 in 10 μ .

Stream at Maranda (W. & T. 2022).

C. ventricosa AG. f. *minus* (sensu A. MAYER) W. & T. comb. nov., measuring 10.2 μ long., 3.7 μ wide, found in a tributary of the R. Makoke (W. & T. 2029). O. MÜLLER listed a *forma minor* for Nyasa, without details of its size and striation characters, so that it is preferable to use A. MAYER's description.

GOMPHONEMA AGARDH 1824.

G. migmatitum W. & T. species nova, *Astigmaticae*, the valves lanceolate-clavate, with the top pole cuneate and the foot pole acute. Axial area very narrow and not widened to form a central area except on one side where a single median stria is shortened; no isolated punctum. Transapical striae weakly radial. (Fig. 83).

Astigmaticae, Valvae lanceolato-clavatae polo superiore cuneato, inferiore acuto, 20.4 μ long., 10.2 μ lat. Area axiali angustissima, area centralis non separata si non in uno latero ubi stria singula brevior est sed non punctata. Striis transapicalibus leniter radiantibus, 15 in 10 μ .

Rice field on migmatite, Sunkoni (W. & T. 2075).

The absence of a stigma makes this distinctive as a species.

G. sonfonense W. & T. species nova, *Stigmaticae*, ovate-lanceolate, the sides slightly concave towards the foot pole, the upper sides gently convex and the apices rounded. Axial area narrow dilating at the central nodule to form an oval central area. Transapical striae radial throughout, 7—9 in 10 μ , the median set more or less shortened on one side the central nodule, an isolated punctum opposite the shortest stria. (Fig. 75).

Stigmaticae, valvae ovato-lanceolatae lateribus inferioribus paulo concavis, superioribus paulo convexis, apicibus rotundatis $85.6\ \mu$ long., $14\ \mu$ lat. Area axiali angusta circum nodulum centalem area centralis ovalis dilatata. Striis transapicalibus omnino radiantibus 7—9 in $10\ \mu$ in media parte in uno latere plus minusve breviores, adversus striam brevissimam puncto singulo.

West bank of Lake Sonfon (W. & T. 2235).

This diatom approaches *C. africanum* G. S. WEST in shape only.

SURIELLACEAE

STENOPTEROBIA DE BREBISSON ex VAN HEURCK 1896

S. recta W. & T. *species nova*, cells straight, linear with long produced ends, the poles less than $1\ \mu$ across. Ribs 4 in $10\ \mu$, transapical striae delicate, interrupted to form a very narrow pseudoraphe. (Fig. 72).

Valvae rectae non sigmoideae, apicibus elongato-productis, 87 — $88\ \mu$ long., 3.7 — $4.3\ \mu$ lat., polaribus usque ad $1\ \mu$. Costae 4 in $10\ \mu$ delicatissimae, striis transapicalibus subtilibus interruptis pseudoraphem angustissimam formantibus.

Lake Sonfon (W. & T. 2241).

This species is near *S. pelagica* HUST. but it is not sigmoid.

SURIELLA TURPIN 1828

S. approximata W. & T. *species nova*, Isopolar, the valves broadly linear with their sides more or less strongly concave and evenly obtuse at their rounded ends. Wings (*alae*) narrow, the wing projection moderately outstanding. Crests and troughs of the ribs on the valve surface about the same width. Wall firm. Transapical striation inconspicuous. Girdle view rectangular. (Figs. 71 & 73).

Isopolares, valvae late lineares lateribus plus minusve valde concavis, apicibus rotundatis et obtusatis, $107\ \mu$ long., $19.5\ \mu$ lat. (in media $13\ \mu$ lat.), $19.5\ \mu$ crass. connectivae. Alae angustae projectionibus suis modice conspicuis. Costis 35 in $100\ \mu$ in superficie valvae cristae alveique aequaliter lati; membrana firma. Striis transapiciuiis. Connectiva rectangularis.

This species resembles *S. Mulleri* HUST. in shape, but it is only half the size and has double the density of ribs. It has some similarity with *S. lincris* v. *constricta* (EHR.) GRUN. where again the ribs are placed more distantly than in our species.

S. Engleri O. MÜLL. *forma sierra-leonensis* W. & T. *forma nova*, less than half the length of most described forms, in outline most like

f. angustior O. MÜLL., the proportions of length to breadth being 1.9 to 1.11. Ribs 7 in 10 μ , the transapical striae very delicate.

Minus quam dimidium longitudinis formarum aliarum, formae *angustiori* simillimum, 41.3—68 μ long., 4.5—6 μ lat., in ratione 1.9—1.11. Costis 7 in 10 μ , striis transapicalibus delicatissimis 30—35 in 10 μ .

R. Makoke at Maranda (W. & T. 2019), R. Chigara (W. & T. 2220 & 2221).

EUGLENOPHYTA

TRACHELOMONAS EHRENBERG 1833

T. gerinkae W. & T. *species nova*, Cylindrical with broadly rounded poles, the flanks straight and the anterior end provided with a low collar or rim which is furnished with 2 very short spines. Membrane yellowish, finely punctate. (Fig. 40).

Cylindricae polaribus late rotundatis, lateribus rectis parte anteriore cum collo humile seu ore cum aculeis brevissimis 2 praedite. Membrana lutea, delicata punctata; 36 μ long., 23 μ lat.

On high ground, Gerinka, on haemaite (W. & T. 2073) and on greenstone (W. & T. 2078).

This species can be compared with *T. cylindrica* EHR. *sect. PLAYF.*, and *T. lacustris* DREZ.

T. sonfonensis W. & T. *species nova*, Cells ovoid, a little pyriform, the posterior pole broadly rounded and furnished with a group of short beady spines. Sides convex, more or less tapering to the rounded upper pole which is provided with a rim-like collar, about 1 μ tall. Membrane smooth, entirely without spines except those at the posterior pole, yellow-brown. (Fig. 41).

Cellulae ovatae paene pyriformes polo posteriore latissime rotundato, cum serie aculeorum brevium margaritiforinium; lateribus convexis plus minusve ad apicem superiorem rotundatum attenuatis. Apex collare oraformi circiter 1 μ alta. Membrana laeve omnino sine aculeis nisi in polo posteriore, fuscolutea. 31.8—32 μ long. 21.2—22.5 μ lat.

West bank of Lake Sonfon, (W. & T. 2235).

This species can be compared with *T. armata* (EHR.) STEIN and *T. Volzii* LEMM.

T. Volzii LEMM., *var. minor* W. & T. *var. nova*, differs from the type in its smaller size. Membrane yellow and granulate. (Fig. 42). Varietas cellulis minoribus. 21—25.5 μ long., 10—12.7 μ lat. 2.8—3.0 μ alt. coll. Membrana lutea et granulata.

MYXOPHYTA (CYANOPHYTA)

Hormogonales

MICROCHAETE [THURET 1875] BORNET & FLAHAULT 1887

M. tropica W. & T. *species nova*, Filaments equally wide throughout their length, the mucilage sheath colourless or pale yellow, never brown. Trichomes blue-green, the cells shorter than broad, apical cell conical and acute. Heterocysts basal and intercalary, the same width as the vegetative cells, rounded-quadrate to circular. Resting cells not seen. (Fig. 87).

Filis aequaliter $21\ \mu$ latis, vagina achroa aut pallido-lutea nunquam fusca, trichomatibus aerugineis $14\text{--}15\ \mu$ latis, cellulis brevioribus quam latis, cellula apicali acuto-conica; heterocystis circiter diametro cellularum, basalibus et intercalatis, rotundato-quadratis vel circularibus. Sporae ignotae.

R. Tonkolili (W. & T. 2108).

Close to *M. uberrima* N. CARTER, but different in size, the sheath and the appearance of the apical cells.

Scytonemataceae

PETALONEMA [BERKELEY 1883] MIGULA 1907.

P. involvens (A. BR.) MIGULA 1907 *var. sierra-leonensis* W. & T. *var. nova*. Filaments with the outer part of the wide mucilage colourless (even in chlor-zinc-iodide), the inner lamellae becoming yellowish, outer pellicle somewhat undulate; divergence of striation is clearly seen in the younger filaments. Branches lie at right angles to their main strands. Cells mostly quadrate, smaller than in the type; heterocysts quadrate. (Fig. 88 and 90).

Filis $20\text{--}22\ \mu$ lat., vaginis crassis, marginibus paulo undulatis, lamellis externis achrois, internis denique luteis etiam in filamentis novis versus marginem radiantibus; ramis patentibus. Cellulis quadratis parvioribus quam typo, $3\text{--}5\ \mu$ lat., heterocystis quadratis circiter $10\ \mu$ diam.

Pool (laterite on greenstone) between Gbulia and Sakasakla (W. & T. 2106); watershed between rivers Kansagbara and Tonkolili (W. & T. 2107); Waia (W. & T. 2108), local.

Oscillatoriaceae

OSCILLATORIA [VAUCHER 1803] GOMONT 1893.

O. formosa BORY 1827 *var. acutius* W. & T. *var. nova*, Trichomes tapering noticeably to the terminal cell which is acutely cuneate, the older cells $4\ \mu$ wide. (Fig. 86).

Trichomatibus ad apices acuto-cuneatos valde attenuatis, cellulis veterioribus $4\ \mu$ crass.

Between the rivers Kansagbara and Tonkolili (W. & T. 2107). The type is known from many parts of Africa, including Cameroons, Gabun, Angola etc.

PHORMIDIUM [KÜTZING 1843] GOMONT 1893.

P. Crouani(i) GOM. 1893 *var. Fritschii* W. & T. *var. nova*, differs from the South American type in having a firm sheath, not diffluent, and in that the terminal cell is broadly rounded instead of being cuneate. Sheath very thin and colourless; no calyptra present. (Fig. 85).

Differt a typo vaginis firmis seu tenuissimis et achrois non diffluentibus, et cellula apicali late rotundata non cuneata, calyptra nulla. Filis $7.5-10.5\ \mu$ diam.

Stream in rice-field, Gbulia (W. & T. 2104).

LYNGBYA [AGARDH 1824] GOMONT 1893

L. Birgei G. M. SMITH 1916 *var. major* W. & T. *var. nova*, Filaments $24-29\ \mu$ wide, the mucilage sheath firm, often constricted opposite the septa. No reproductive cells seen. (Fig. 91).

Filis $24-29\ \mu$ lat., vaginis $3\ \mu$ lat., firmis ad septa saepe constrictis Spora ignota.

R. Malankala (W. & T. 2228) and several places in R. Kangofurina (W. & T. 2229, 2231 and 2239).

Some unusual algae in the Collection merit comment and have been illustrated. Among the desmids the genus *Cosmarium* is well represented with over 70 taxa from which we have selected the following:

Cosmarium commisurale [BRÉB. in MENEGH. 1840] RALFS 1848 *var. crassum* NORDST. 1870, is a very rare variety found in Lake Sonfon (W. & T. 2241). Fig. 44.

C. concentricum TURN. 1892 *var. radiatum* W. & G. S. WEST 1897 was originally described from Angola. We have found it in several samples from the Sula Hills (W. & T. 2103, 2106, 2108, 2110) in the neighbourhood of Gbulia; the specimens in the first of these, taken from a pool by the track from the village to Sakasakala, were larger than the Angola plants. viz., $17\ \mu$ long, $17\ \mu$ wide and also slightly more flattened at the apex. The granules were acute. (Fig. 14).

C. Puellebornii SCHMIDLE 1902 occurred near Gerinka (W. & T. 2074 and 2075), the dimensions of the specimens agreeing with those described from the Amazon, 70—77 μ long, 59—60 μ wide, the isthmus 24—28 μ across. Membrane thick with a radial arrangement of granulation. Vertical view of semicell also circular; its median constriction deep. Chromatophore axile with short lobes and a single pyrenoid. The species has been recorded for East Africa. (Fig. 35).

C. impressulum ELFV. 1881 *f. minor* TURN. 1892 found at Gerinka (W. & T. 2074), measured only 15 μ long, 10.5 μ wide. Previously recorded for India and Newfoundland, our material seems to be the first African notice of this small desmid. (Fig. 27).

C. pseudonitidulum NORDST. 1873, which was originally determined on material from Central China, appeared in the R. Kagleguma (W. & T. 2076), but the specimens were shorter than usual, 37.5—40.2 μ long, 32—36 μ wide, 19—20 μ thick, the membrane delicately punctate all over. The chromatophore had two pyrenoids. The desmid has been seen in the Belgian Congo. (Fig. 37).

C. subglobosum NORDST. 1878 occurred at Gerinka (W. & T. 2073) and in a pool in a grassy field between the rivers Signakolo and Kildagaran (W. & T. 2103) where it closely resembled a form described by VAN OYE for the Belgian Congo, measuring 31—33 μ long, 18—21 μ wide. (Fig. 12).

C. subtumidum NORDST. in WITTR. & NORDST. 1878 occurs in several gatherings; at Gerinka in a pool with high iron content (W. & T. 2073) the specimens had their apices evenly rounded so that they compared closely with NORDSTEDT's original figures rather than with the truncate forms mainly recorded. 25—27.5 μ long, 22.5—23.3 μ wide. (Fig. 23).

Two further desmids require attention.

Xanthidium Raciborskii GUTW. 1902 occurs in a small stream at Sunkoni (W. & T. 2077) but the specimens showed the apex and sides more deeply concave than those shown by KRIEGER for his Indonesian specimens (1932, pl. 25, fig. 4); variations in shape between the two semicells of the same plant were observed. 40—49.5 μ long, 38—42 μ wide. (Fig. 26).

Micrasterias ceylanica FRITSCH 1907 from a stream between Kunya and Wesima (W. & T. 2237); mostly plants with short sturdy spines

not always directed downwards, and broader than the published dimensions, 60—63.6 μ long, 61—65.5 μ wide, the polar lobe 45—48.6 μ wide. (Fig. 28).

We include thirteen diatoms in our illustrations other than those of new taxa.

Coscinodiscus lacustris GRUN. in CLEVE & GRUN. *var. septentrionalis* (GRUN.) RATTRAY of which a substantial fragment occurred in a slide made from the gathering (W. & T. 2080) from the R. Tonkolili agreeing closely with the description and illustration of a diatom considered to be distributed in arctic Eurasia. The marginal thorns are 10 in 10 μ (8—9 in 10 μ are given for the variety as against 5—7 in the type), the puncta rows about 10 in 10 μ and the diameter approximately 45 μ . (Fig. 67).

Melosira Roeseana RABH. is illustrated from R. Chigara (W. & T. 2221); auxospores of *M. granulata* (EHR.) RALFS in PRITCHARD are presumably those of status γ which were found in some quantity in Lake Sonfon (W. & T. 2235) in March 1952. (Figs. 52 and 53 respectively).

Fragilaria strangulata (ZANON) HUST. was found in quantity in a pool at Maranda (W. & T. 2028); there is no doubt that the majority of the specimens are identical with HUSTEDT's plants and we have seen the species elsewhere in Sierra Leone. The teeth are readily visible, particularly in girdle view, in styrax mounts, whilst preparations in realgar or arsenic selenide show them as obtuse knobs. ZANON's original illustration and diagnosis (1938, fig. 14) gave no indication of marginal teeth but when frustules are viewed from directly above the teeth or knobs are almost invisible being set a little within the edge of the diatom. Figs. 70 a & b represent the normal forms, 70 c our new *forma constricta*, *q. v.*

Synedra ulna (NITZSCH) EHR., *var. recta* ROSS in POLUNIN, occurs widely distributed, mainly in streams. A *lusus* is shown in Fig. 61.

Eunotia pectinalis (O.F.M.) RABH. *var. cristula* BERG, appears in Lake Sonfon on the west bank (W. & T. 2235, 2236.); the ventral inflation of these diatoms is often more pronounced than shown by BERG (1939, fig. 22). Our plants measure 28—29.5 μ long, 7 μ wide, and possess 7 striae in 10 μ . (Fig. 51).

E. robusta RALFS in PRITCHARD is frequently found. The specimens from R. Kangofurina (W. & T. 2228 to 2232) contains frustules more

slender than usual, 52.5—55 μ long, 7 μ wide at the humps, 5.5 μ wide at the troughs between the humps; striae 10—11 in 10 μ . (Fig. 50).

Actinella pliocenica HÉRIB. & PERAG. in HÉRIB., was first detected in the R. Kangofurina (W. & T. 2239) and Lake Sonfon (W. & T. 2241), but has since been found in widely scattered parts of Sierra Leone, a full list being given elsewhere (WOODHEAD & TWEED 1957) of these coastal localities. The species had only been known before as a fossil from France, based on an incomplete specimen, which, however, depicted the acute end of the upper pole which makes *A. pliocenica* easy to recognise. The African material is abundant and shows much variation in breadth, some being identical with the original description and others grading to more slender plants; length 102.3—120 μ long, upper swelling 6.5—10.2 μ wide, the stem 3 μ wide. Striae 12 in 10 μ , not visibly punctate or spiny. Raphe conspicuous. (Fig. 55).

Navicula Lagerheimii CLEVE appears in several places and include plants smaller than measurements made of HUSTEDT's illustrations (1949) of Congo material which are as small as 16 μ long, 5 μ wide. In a tributary of the R. Seli (W. & T. 2100) where the species was abundant numerous specimens were in the range 12.0—15.2—(17.5) μ long, 4.5—6.3—(7.2) μ wide. CLEVE did not mention an isolated punctum in his diagnosis. (Figs. 54, 66).

N. Lagerheimii var. *intermedia* HUST. in A. S. showed dimensions 27 μ long, 8.4 μ wide, the diatoms being seen in the same place (W. & T. 2100) and at Sunkoni (W. & T. 2077). (Fig. 65).

Pinnularia gibba EHR. non W. SM. var. *sancta* (GRUN. ex CLEVE) MEISTER, from R. Kangofurina (W. & T. 2239) and Lake Sonfon (W. & T. 2235) closely resembles HUSTEDT's material from the eastern Belgian Congo (Fig. 56 & 58).

Gomphonema lanceolatum EHR. var. *insigne* (GREG.) CLEVE, has been seen at Maranda, etc (W. & T. 2022, 2029, 2220 & 2225) measuring 37—40 μ long, 7—8 μ wide, with 7—10 striae in 10 μ (Fig. 74).

Nitzschia lancettula O. MÜLL. from Maranda (W. & T. 2019) and Lake Sonfon (W. & T. 2241) showed dimensions of 18.6—25 μ long, 4.5—5.0 μ wide, with 9—10 carinal puncta in 10 μ , 16 strong striae in 10 μ . HUSTEDT (1949) considered this endemic for tropical Africa.

Our plants lie within the range of *forma minor* O. MÜLL. which HUSTEDT sank within the type by reason of the discovery of intergrading sizes.

Among the Euglenophyta we show one variety, *Euglena spirogyra* EHR. var. *suprema* SKUJA from the R. Kansagbara (W. & T. 2232) slightly larger than SKUJA described and not twisted, 190 μ long, 38 μ wide. Paramylon bodies large, 42—46 μ long, 10 μ wide. All granules on the membrane equally large. (Fig. 49).

Plate I.

Fig. 1. *Ichthyocercus sierra-leonensis* sp. n., front view and oblique apical view. Scale A.

Fig. 2. *Euastrum platycerum* v. *decoratum* var. n. Scale A.

Fig. 3. *Euastrum pratense* sp. n. side view, cf. fig. 6. Scale A.

Fig. 4. *Triploceros gracilis* v. *torrida* var. n. portion of semicell. Scale B.

Fig. 5. *Triploceros gracilis* v. *africana* var. n., portion of semicell (cf. side view, fig. 11), Scale B.

Fig. 6. *Euastrum pratense* sp. n. front views of entire cell and separated semicells. Scale A.

Fig. 7. *Xanthidium sonfonense* sp. n., front, side and apical views. Scale A.

Fig. 8. *Euastrum tonkoliliense* sp. n., front views. Scale A.

Fig. 9. *Euastrum obesum* v. *minor* var. n., front view. Scale A.

Fig. 10. *Mallomonas glabra* sp. n., Scale B. (oil-immersion).

Fig. 11. *Triploceros gracilis* v. *africana* var. n., side view of apical part. Scale Z.

Fig. 12. *Cosmarium subglobosum* NORDST. forma, front view. Scale A.

Fig. 13. *Staurastrum gerinkae* sp. n., front and apical views. Scale A.

Fig. 14. *Cosmarium concentricum* v. *radiatum* W. & G. S. WEST, front view. Scale A.

Fig. 15. *Euastrum sinuosum* v. *africanum* var. n., front view. Scale B.

Fig. 16. *Cosmarium subauriculatum* v. *duplo-major* var. n., front view. Scale A.

Fig. 17. *Closterium rugosum* sp. n., entire cell (left-hand figure) drawn to Scale A; right hand figure apical part of semicell as viewed under oil-immersion lens, freehand.

Fig. 18. *Pleurotaenium trabecula* v. *latior* var. n., semicell, own scale inserted.

Fig. 19. *Euastrum platycerum* v. *decoratum* var. n., front view, Scale A.

Fig. 20. *Mallomonas sonfonensis* sp. n., own scale attached.

Fig. 21. *Phacus spirogyra* DREZ. forma, own scale attached.

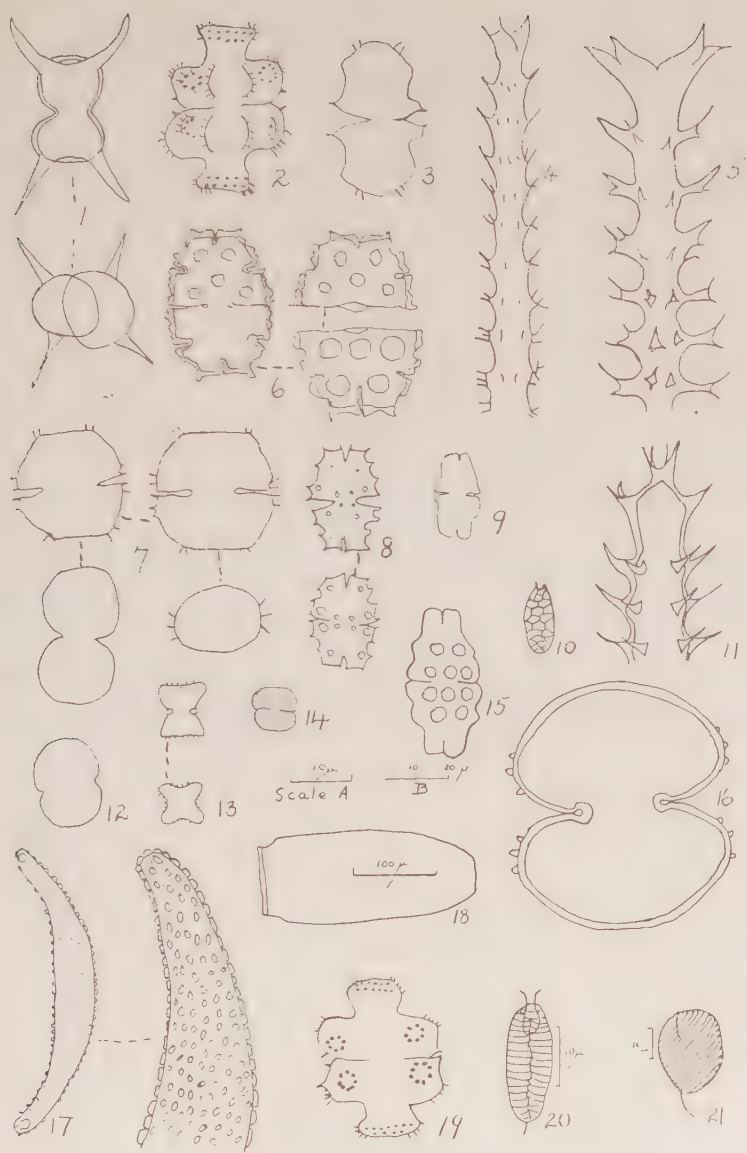


Plate II

- Fig. 22. *Micrasterias apiculata* f. *angustior* forma n., complete cell and semicell in front view. Scale A.
- Fig. 23. *Cosmarium subtumidum* NORDST. forma, front view. Scale B.
- Fig. 24. *Euastrum dubium* f. *africanum* forma n., front views. Scale B.
- Fig. 25. *Micrasterias americana* v. *hybrida* var. n., complete cell and semicell in front view. Scale A.
- Fig. 26. *Xanthidium Raciborskii* GUTW. formae, front and apical views, the right hand plant showing dissimilar semicells. Scale B.
- Fig. 27. *Cosmarium impressulum* f. *minor* TURNER, front view. Scale C.
- Fig. 28. *Micrasterias ceylanica* FRITSCH forma, front view. Scale B.
- Fig. 29. *Micrasterias kangofurinensis* sp. n., front view Scale B.
- Fig. 30. *Cosmarium nudum* f. *minor* forma n., front and apical views Scale C.
- Fig. 31. *Micrasterias truncata* v. *tridentata* f. *marandae* forma n., front view. Scale B.
- Fig 31a. *Staurastrum africanum* sp. n., front and apical views. Scale A.



Plate III

- Fig. 32. *Cosmarium sierra-leonensis* sp. n., front and apical views, ornamentation shown in part. Scale A.
- Fig. 33. *Cosmarium kangofurinense* sp. n., front view, ornament shown for one semicell. Scale A.
- Fig. 34. *Cosmarium gbuliense* sp. n., front, basal and side views, ornament shown for one semicell. Scale A.
- Fig. 35. *Cosmarium Fuellebornii* SCHMIDLE, front view, Scale A.
- Fig. 36. *Cosmarium pseudobaronii* sp. n., front view, ornament shown in part. Scale A.
- Fig. 37. *Cosmarium pseudonitidulum* NORDST. forma, front and basal views. Scale A.
- Fig. 38. *Xanthidium pseudoraciborskii* sp. n., front and basal views, ornament shown for one semicell. Scale A.
- Fig. 39. *Cosmarium Stansfieldii* sp. n., front, side and apical views. Scale A.
- Fig. 40. *Trachelomonas gerinkae* sp. n., Scale B.
- Fig. 41. *Trachelomonas sonfonensis* sp. n., three loricae, the central specimen with its own scale, the other two. Scale B.
- Fig. 42. *Trachelomonas Volzii* v. minor var. n., own scale.

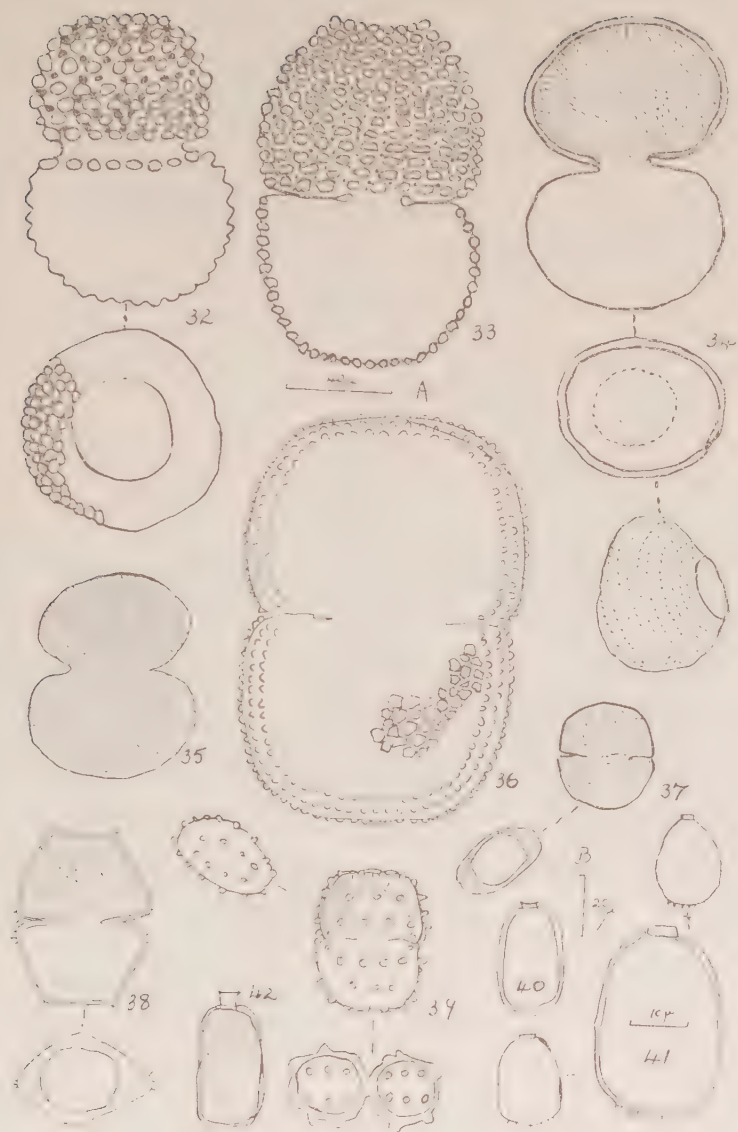


Plate IV.

- Fig. 43. *Phymatodocis irregulare* f. *sonfonensis* forma n., mature zygosporoes, and isolated cell of filament. Own scale.
- Fig. 44. *Cosmarium commissurale* v. *crassum* NORDST., front and apical views. Scale A.
- Fig. 45. *Staurastrum sonfonense* sp. n. front views of cells and semicells. Scale A.
- Fig. 46. *Cosmarium capense* f. *minor* forma n., Scale A. front view.
- Fig. 47. *Pleurotaenium gloriosum* f. *sonfonense* forma n., part of semicell, showing terminal ornament, scale. A.
- Fig. 48. *Debarya sierra-leonensis* sp. n., quadrate zygote and mucilage, own scale.
- Fig. 49. *Euglena spirogyra* v. *suprema* SKUJA, scale A.

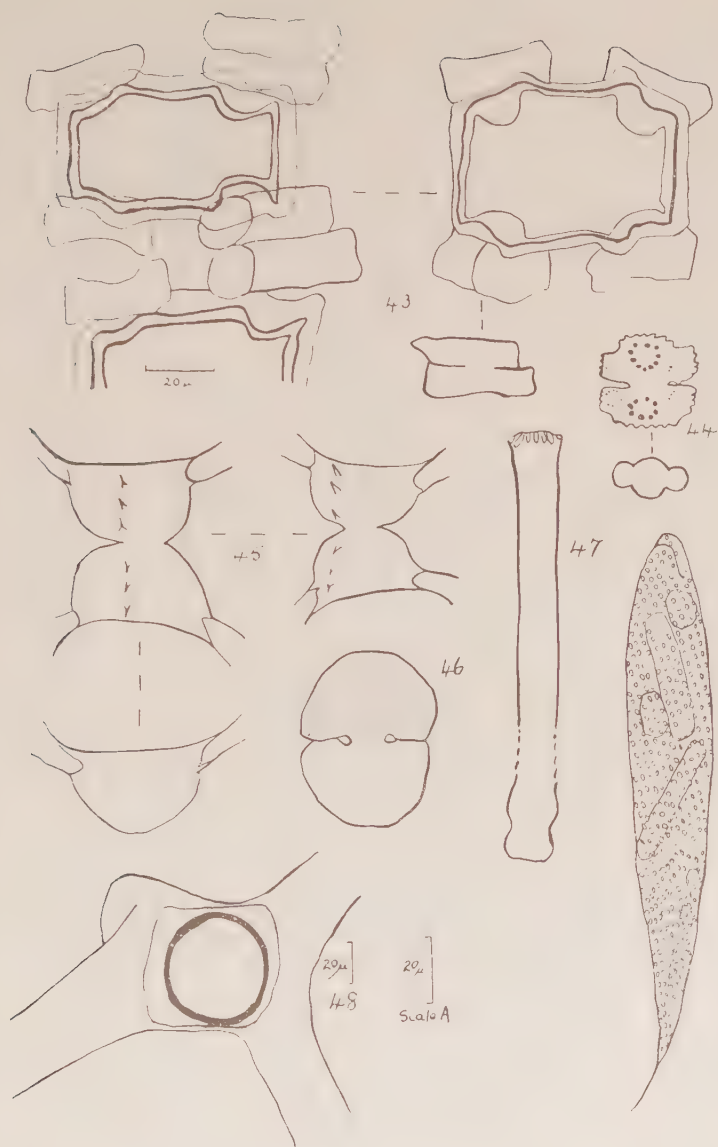


Plate V.

- Fig. 50. *Eunotia robusta* RALFS *forma*, scale A.
 Fig. 51. *Eunotia pectinalis* var. *cristula* BERG, scale A.
 Fig. 52. *Melosira Roeseana* RABH., scale A.
 Fig. 53. *Melosira granulata* (EHR.) RALFS, auxospores (a) scale A, (b) own scale.
 Fig. 54. *Navicula Lagerheimii* CLEVE, scale A.
 Fig. 55. *Actinella pliocenica* UÉRIB. & PERAG. (a) scale A, (b) & (c) own scale;
 (c) shows a frequent deformity
 Fig. 56. *Pinnularia gibba* v. *sancta* (GRUN.) MEISTER, showing the irregularity
 of striation. Scale B.
 Fig. 57. *Achnanthes africana* sp. n., raphe and raphe-less valves, scale A.
 Fig. 58. *Pinnularia gibba* v. *sancta* (GRUN.) MEISTER, Scale B.
 Fig. 59. *Eunotia chigara* sp. n., Scale A.
 Fig. 60. *Pinnularia Millsii* sp. n., scale B.
 Fig. 61. *Synedra ulna* v. *recta* ROSS *lusus*, scale B.
 Fig. 62. *Eunotia Zanonii* sp. n., scale A.
 Fig. 63. *Pinnularia Smithii* f. *subparallela forma nova*, scale A.
 Fig. 64. *Eunotia curvata* (KTZ.) Lagerst., scale A.



Plate VI.

- Fig. 65. *Navicula Lagerheimii* v. *intermedia* HUST., scale A.
Fig. 66. *Navicula Lagerheimii* CLEVE, scale A.
Fig. 67. *Coscinodiscus lacustris* v. *septentrionalis* (GRUN.) RATTRAY, portion of a fragmented plant, scale A.
Fig. 68. *Cymbella hybrida* v. *sierra-leonensis* var. *n.*, scale A.
Fig. 69. *Cymbella calida* sp. *n.*, scale B.
Fig. 70. *Fragilaria strangulata* (ZANON) HUST., (a) & (b) scale A; (c) *f. constricta* forma *n.* scale A.
Fig. 71. *Surirella approximata* sp. *n.*, polar part, scale A.
Fig. 72. *Stenopterobia recta* sp. *n.*, scale A.
Fig. 73. *Surirella approximata* sp. *n.*, entire frustule, own scale.
Fig. 74. *Gomphonema lanceolatum* v. *insignis* (GREG.) CLEVE, scale of fig. 73.
Fig. 75. *Gomphonema sonfonense* sp. *n.*, scale B.
Fig. 76. *Pinnularia sierra-leonensis* sp. *n.*, detail of middle portion and poles, scale B; entire valve (b) own scale.

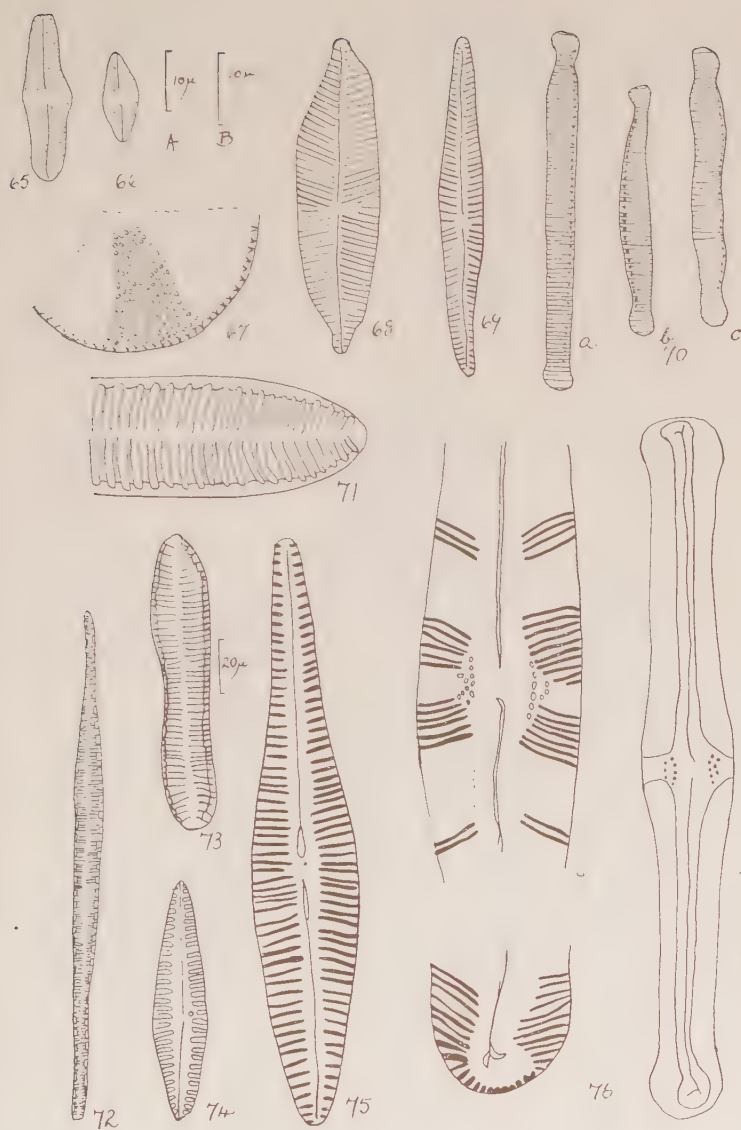


Plate VII

- Fig. 77. *Nitzschia lancettula* O. MÜLL., scale A.
Fig. 78. *Navicula sunkonensis* sp. n., scale A.
Fig. 79. *Pinnularia pseudobrandelii* sp. n., own scale.
Fig. 80. *Navicula subtilissima* f. *rostrata forma n.*, scale A.
Fig. 81. *Pinnularia seliana* sp. n., scale B.
Fig. 82. *Pinnularia Millsii* sp. n., detail of structure, scale A.
Fig. 83. *Gomphonema migmatitum* sp. n., scale B.
Fig. 84. *Pinnularia sonfonensis* sp. n., outline, own scale; detail of structure, scale B.



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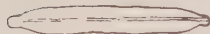
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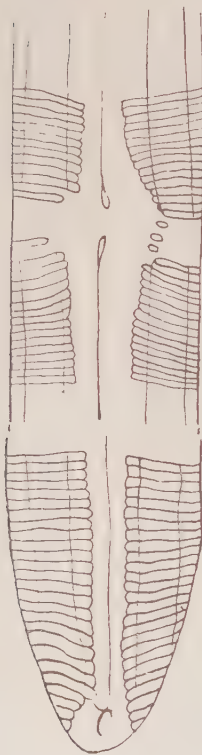
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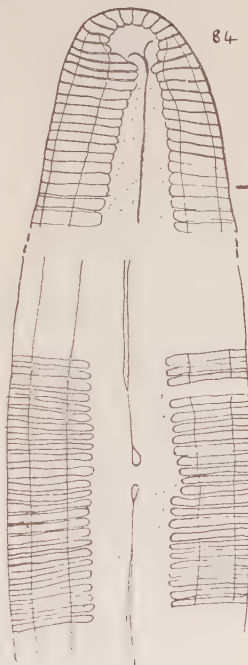
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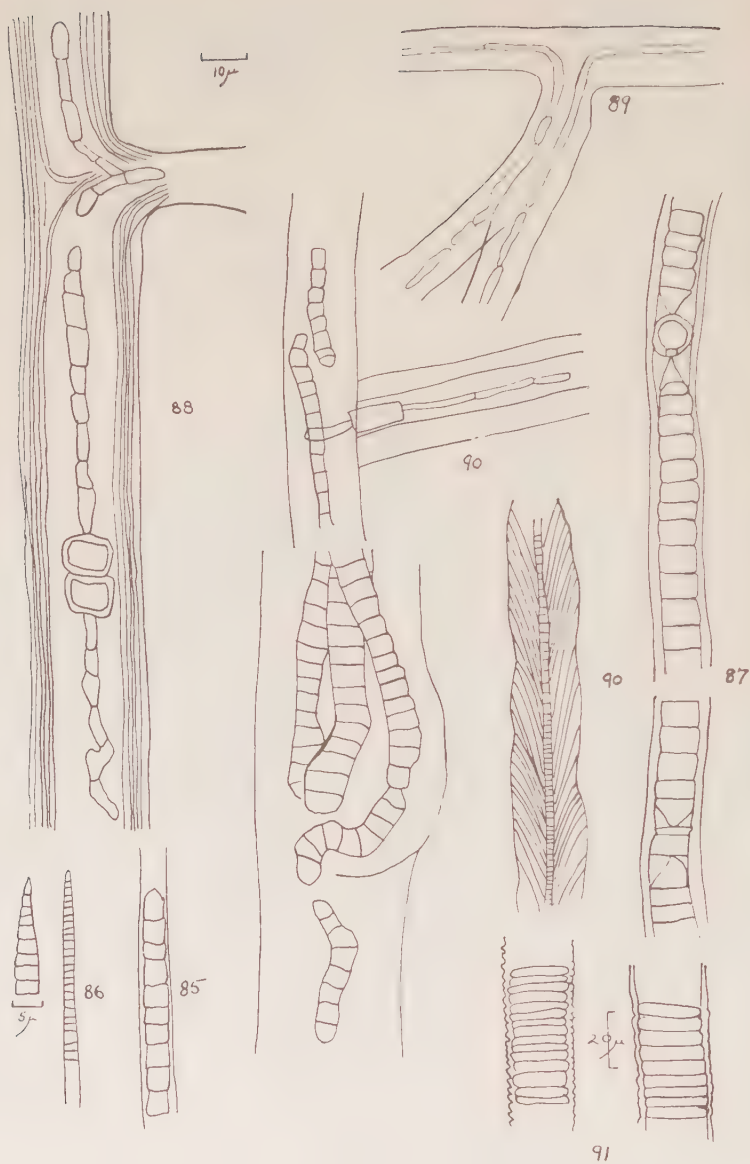


Plate VIII

- Fig. 85. *Phormidium Crouani* var. *Fritschii* var. n., scale A.
 Fig. 86. *Oscillatoria formosa* var. *acutius* var. n., freehand and scale A.
 Fig. 87. *Microchaete tropica* sp. n., scale A.
 Fig. 88.
 Fig. 89. *Petalonema involvens* var. *sierra-leonensis* var. n. scale A.
 Fig. 90.
 Fig. 91. *Lyngbya Birgei* var. *major* var. n., own scale.

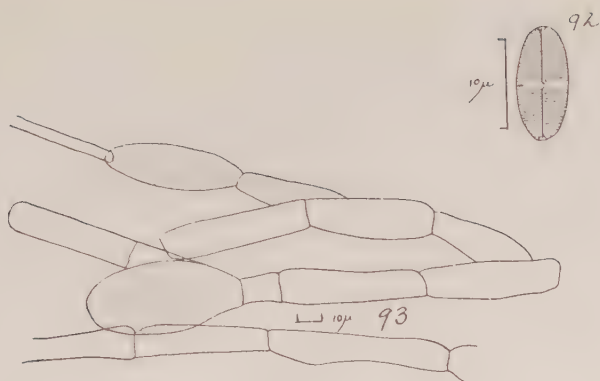


Plate IX.

Fig. 92. *Navicula submuticoides* sp. n. own scale.

Fig. 93. *Pithophora tropica* sp. n. own scale.

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Zur Planktonkunde Spitzbergens

von

KUNO THOMASSON

Växtbiologiska Institutionen, Uppsala

Unsere Kenntnis des Süßwasserplanktons in arktischen Gewässern gründet sich hauptsächlich auf Untersuchungen in Gewässern auf arktischen Inseln. Unter diesen nimmt zweifellos Spitzbergen den hervorragendsten Platz ein, da dieses Gebiet zu den am frühesten untersuchten gehört und von den zahlreichsten Expeditionen besucht wurde.

Da die meisten Forschungsreisen West-Spitzbergen zum Ziel hatten, gründet sich unser Wissen von der Algenflora des Süßwassers von Spitzbergen hauptsächlich auf von dort heimgebrachte Sammlungen. Aus diesem Grunde dürften die folgenden kurzen Angaben über das Süßwasserplankton der Gewässer auf dem Nordostland bei Murchinson Bay ihr Interesse haben.

Die folgenden Notizen gründen sich auf Sammlungen, die im Sommer 1957 während der Schwedisch-Finländisch-Schweizerischen Nordostland-Expedition von Dr. ANDERS HÄGGBLOM gemacht wurden, der der „Glaziologengruppe VALTER SCHYTT“ angehörte. Ich bin meinem Freund ANDERS HÄGGBLOM zu grossem Dank verpflichtet dafür, dass er neben seinen anstrengenden Aufgaben sich auch diesen kargen Gewässern und ihrer Lebewelt widmen wollte. Die von ihm mitgebrachten Planktonproben dürften von dem arktischen Süßwasserplankton in den Gewässern des Nordostlandes ein gutes Bild geben.

Alle im Folgenden behandelten Planktonproben wurden in Juli—August an der Murchison Bay im Becken zwischen der Küste des Fjordes und dem Rande von Westfonna gesammelt. Die erste Gruppe der untersuchten Gewässer liegt im Gebiet um Sälvik bei Hjembukta.

Lake Allone.

Ein kleiner, etwa 40 m ü.d.M. gelegener See, etwa 150 × 200 m gross. Zur Zeit der Entnahme der Proben am 23. Juli war der südliche Teil des Sees mit Eis bedeckt, am Strand befand sich ein



Die Landschaft bei Murchinson Bay. 1. Triple Lakes; 2. Celsius Ice Lake; 3. Ice-Eye Lake; 4. Lake Allone; 5. Crystal Lake; 6. Third Lake; 7. Little North Lake; 8. Home Lake; 9. Green Ice Lake; 10. Palosuo Ice Lake; 11. Lake Dorrit; 12. Sun Lake; 13. Glacial Lake. Flugaufnahme Norsk Polar-institut.

Schneewall. Der See hat seinen Abfluss gegen Norden in den Fjord. Seine grösste Tiefe ist etwa 5—8 m, der Boden Stein und Tundramoräne, im zentralen Teil besteht der Boden aus Lehm. Oberflächentemperatur des Wassers 3,6° C. Im Plankton, das hauptsächlich aus *Dinobryon sociale*, *Polyarthra dolichoptera* und *Cyclops vicinus* bestand, wurden folgende Arten notiert: *Oscillatoria* sp., *Dinobryon sociale*, *Tabellaria* f. var. *flocculosa*, *Cosmarium botrytis*, *Argonotholca foliacea*, *Keratella hiemalis*, *Polyarthra dolichoptera*, *Chydorus sphaericus*, *Cyclops vicinus*.

I c e - e y e L a k e.

Ein kleiner Tümpel, etwa 45 × 30 m, am tiefsten Punkt einer kesselförmigen Vertiefung gelegen. Er liegt etwa 150 m genau westlich von Lake Allone, etwa 45 m ü.d.M. Zur Zeit der Schneeschmelze dürfte dieser Tümpel einen Abfluss zum Lake Allone haben. Die Tiefe erreicht nur etwa 50 cm, der Boden besteht aus kleinen Steinen und Lehm; auch Frostringe mit Lehm im Zentrum kommen vor. Zur Zeit der Probenahme am 23. Juli war die Temperatur des Wassers 8,4°. Die Probe wird von *Argonotholca foliacea* dominiert und ihr benthischer Charakter spiegelt sich in dem reichlichen Gehalt an Detritus wider. Folgende Organismen wurden notiert: *Chroococcus tenax*, *Gloeocapsa alpina*, *Gomphosphaeria aponina*, *Nostoc kihlmani*, *Closterium leibleinii*, *Cosmarium botrytis*, *Argonotholca foliacea*, *Euchlanis dilatata*, *Polyarthra dolichoptera*, *Cyclops vicinus*.

C r y s t a l L a k e.

Der See war zur Zeit der Probenahme am 23. Juli ganz mit 30—35 cm dickem Kristalleis bedeckt. Er liegt etwa 50 m ü.d.M. und fliesst durch einen Bach zum Lake Allone ab. Seine grösste Tiefe ist etwa 5—10 m. Die Probe wurde in einer Eisspalte an der NW-Seite des Sees genommen. An dieser Stelle besteht der Boden aus Silt mit grossen Blöcken aus Schiefer und Sandstein. Die Temperatur des Wassers war nur 1,2° und der Inhalt der Probe sehr dürftig: *Oscillatoria* sp., *Tabellaria* f. var. *flocculosa*, *Cosmarium holmiense* var. *integrum*, *Cosm. pulcherrimum* var. *boreale* (L. 66 µ Br. 47 µ), *Kellicottia longispina*, *Keratella hiemalis*, *Polyarthra dolichoptera*, *Chydorus sphaericus*.

Eine Probe wurde in dem Bach genommen, der Crystal Lake mit Lake Allone verbindet. Hier war die Temperatur des Wassers 5,2°. Nur wenige Organismen wurden notiert: *Oscillatoria* sp., *Dinobryon sociale*, *Ankistodesmus falcatus*, *Cosmarium cyclicum* var. *arcticum* (L. und Br. 75 µ), *Keratella hiemalis*, *Lepadella patella*, *Polyarthra dolichoptera*, *Cyclops vicinus*.

H o m e L a k e.

Ein kleiner (100 × 45 m) und seichter (1,8 m) Tümpel, der 6 m

ü.d.M. in einer kesselförmigen Einsenkung nahe dem Fjord bei Hjembukta liegt. Sein Wasser erreicht durch einen Bach den Fjord. Der Boden besteht aus Stein, Silt und Lehm, eine sichtbare benthische Algenvegetation wurde bemerkt. Die relativ hohe Wassertemperatur variierte zwischen 8 und 12°, beruhend auf der Insolation. Im Tümpel kommt *Lepidurus arcticus* vor, der von Dr. HÄGGBLOM ausserdem noch in einem anderen ähnlichen Strandsee mit geringer Wassertiefe (2—3 m) und relativ hoher Wassertemperatur beobachtet wurde. Diese beiden Fundorte bestätigen die von OLOFSSON, 1918, S. 389, gegebenen Charakteristika. Das Plankton im Home Lake wurde am 23. Juli von *Uroglena americana* und *Polyarthra dolichoptera* dominiert. Folgende Plankter wurden notiert:

<i>Gomphosphaeria aponina</i>	<i>Staurostrum furcigerum</i>
<i>Peridinium inconspicuum</i>	— <i>longipes</i> var. <i>contractum</i> —
<i>Uroglena americana</i>	sehr selten.
<i>Diatoma vulgare</i>	— <i>lunatum</i>
<i>Fragilaria capucina</i>	— <i>lunatum</i> fa. — eine eigen-
<i>Tabellaria</i> f. var. <i>flocculosa</i>	tümliche Form, die einerseits
<i>Eudorina elegans</i>	am Ende des einen Armes 2
<i>Pandorina morum</i>	Stacheln besitzt, und bei der
<i>Paulschulzia pseudovolvox</i>	andererseits die Granulae am
<i>Geminella interrupta</i>	Scheitel als Verrucae ausge-
<i>Ankistrodesmus falcatus</i>	bildet sind — je zwei Punkte
<i>Botryococcus braunii</i>	sind zu grösseren Warzen ver-
<i>Oocystis submarina</i>	bunden, welche in der Schei-
<i>Coelastrum microporum</i>	telansicht die Seitenränder
<i>Cosmarium boreale</i> fa.	intramarginal begrenzen.
— <i>botrytis</i>	— <i>punctulatum</i> var. <i>striatum</i>
— <i>capitulum</i> var. <i>groenlandi-</i>	<i>Ophrydium versatile</i>
<i>cum</i>	<i>Argonotholca foliacea</i>
— <i>conspersum</i> var. <i>latum</i>	<i>Cephalodella</i> spp.
— <i>contractum</i> var. <i>ellipsoideum</i>	<i>Collotheca libera</i>
fa. — WEST'S Monograph,	<i>Euchlanis meneta</i>
T. 61, Abb. 30.	<i>Kellicottia longispina</i>
— <i>holmii</i>	<i>Lepadella patella</i>
— <i>ochthodes</i> var. <i>amoebum</i>	— <i>triptera</i>
— <i>subcrenatum</i>	<i>Mytilina mucronata</i>
— <i>umbilicatum</i>	<i>Polyarthra dolichoptera</i>
<i>Pleurotaenium truncatum</i>	<i>Trichocerca uncinata</i>
<i>Staurostrum bieneanum</i> fa. <i>spets-</i>	<i>Daphnia</i> l. <i>longispina</i>
<i>bergensis</i>	— <i>pulex</i>
— <i>brebissonii</i>	

Little North Lake.

Dies ist eigentlich eine Fortsetzung des vorhergehenden Sees, von dem er durch einen 3 m breiten und 0,3 m hohen Landstreifen getrennt ist, welcher bei höheren Wasserstand überschwemmt sein dürfte. Dieser Tümpel misst nur etwa 60 x 80 m und hat eine größte Tiefe von 1 m. Er liegt 6,3 m ü.d.M. Bei der Probennahme am 27. Juli war die Temperatur des Wassers 9°. Die Netzprobe enthielt grosse Mengen von Detritus, unter welchen notiert wurden:

<i>Aphanocapsa elachista</i>	<i>Cosmarium bioculatum</i>
<i>Chroococcus minutus</i>	— <i>botrytis</i>
— <i>turgidus</i>	— <i>capitulum</i> var. <i>groenlandicum</i>
<i>Gomphosphaeria aponina</i>	— <i>margaritatum</i>
<i>Merismopedia punctata</i>	— <i>subrenatum</i> fa.
<i>Nostoc kihlmani</i>	— <i>tetraophtalmum</i> fa.
<i>Synura uvella</i>	<i>Pleurotaenium truncatum</i>
<i>Cyclotella antiqua</i>	— <i>truncatum</i> var. <i>farguharsonii</i>
<i>Meridion circulare</i>	<i>Staurastrum furcigerum</i>
<i>Tabellaria</i> f. var. <i>flocculosa</i>	— <i>inflexum</i>
<i>Chlamydomonas planctogloea</i>	— <i>lunatum</i>
— sp.	<i>Ophrydium versatile</i>
<i>Pandorina morum</i>	<i>Argonotholca foliacea</i>
<i>Oocystis solitaria</i> var. <i>maxima</i>	<i>Cephalodella</i> sp.
<i>Scenedesmus quadricauda</i>	<i>Euchlanis meneta</i>
<i>Closterium lunula</i>	<i>Keratella hiemalis</i>
	<i>Polyarthra dolichoptera</i>

Der hauptsächlich cycloplanktonische Charakter der Probe ist offenkundig. Von Interesse ist, dass die in entsprechenden Proben aus stillstehenden Gewässern so charakteristischen *Chlamydomonas* hier fehlen. Das Vorkommen von *Scenedesmus quadricauda* ist keine Bedeutung, da sie nur in wenigen Exemplaren notiert wurde.

Third Lake of Hjembukta.

Third Lake, 14 km östlich der kleinen Insel von Hinn Lake und 1 km nördl. vom Hjembukta bei Hinnbukt. Es liegt 7 m ü. d. M. sein Maximum und ausser 17 m, seine Tiefe 65 cm. Wenn das Wasser durch die Stämme aus dem Wind wird, so sinkt die Temperatur immer ziemlich hoch, und wenn die Temperatur 5°. Der Boden besteht aus Steinen und Lehm, die bläuliche Algenvegetation ist üppig. In der Probe, die von *Polyarthra dolichoptera* dominiert war, wurde notiert:

Aphanothece clathrata
Chroococcus turgidus
Gomphosphaeria aponina
 — *aponina* var. *cordiformis*
Merismopedia punctata
Nostoc kihlmani
Synechococcus aeruginosus
Cyclotella antiqua
Diatoma elongatum
Carteria ovata
Chlamydomonas sp.
Eudorina elegans
Pandorina morum
Botryococcus braunii

Closterium lunula
 — *venus*
Cosmarium botrytis
 — *consersum* var. *latum*
 — *holmii*
 — *umbilicatum*
Pleurotaenium truncatum
 — *truncatum* var. *farquharsonii*
Staurostrum inflexum
Olpidium endogenum
Argonotholca foliacea
Cephalodella sp.
Lepadella patella
Polyarthra dolichoptera

Die folgenden drei Seen sind bei Hjembukta in der Richtung gegen Caine Valley gelegen, das von einem Gletscherbach durchflossen wird.

Sun Lake.

Der See ist klein und misst etwa 250×350 m. Er liegt 62 m ü.d.M., seine größte Tiefe ist 15 m. Bei der Probenahme am 26. Juli war der ganze See mit Eis bedeckt, die Probenahme geschah in einer Eispaße, die Temperatur des Wassers war 3°. Das Plankton wurde von *Dinobryon sociale* und *Polyarthra dolichoptera* dominiert. Außerdem wurde notiert: *Peridinium inconspicuum*, *Tabellaria* f. var. *flocculosa*, *Gomatorryzon aculeatum*, *Xanthidium armatum*, *Keratella hiemalis*, *Cyclops vicinus*.

Lake Dorrit.

Auch dies ist ein kleiner See mit den Abmessungen $200 \times 50 \times 100$ m und einer geschätzten Tiefe von 15 m. Der See wird an mehreren Stellen von schmelzendem Eis gespeist. Am 26. Juli war die Temperatur des Wassers 1,2°, etwa 26% der Oberfläche des Sees waren noch von Eis bedeckt. Der See liegt 39 m ü.d.M., das umgebende Terrain ist flach, die größte relative Höhe in der Nähe des Sees beträgt 12 m. Das Plankton wurde von *Dinobryon sociale* und *Polyarthra dolichoptera* dominiert. Außerdem wurde notiert: *Peridinium inconspicuum*, *Tabellaria* f. var. *flocculosa*, *Staurostrum inflexum* var. *erectum*, *Keratella hiemalis*, repräsentiert durch alle von OTTARSON, 1918, S. 612, Abb. 67 und 69 abgebildeten Typen.

Green Ice Lake

Dieser recht sichte See mit einer Größe von 200×100 m wird

von dem oben genannten Came Valley Gletscherbach durchflossen. Der See liegt 12 m ü.d.M. Sein rechtes Ufer wird von einem mit Schnee und Eis bedeckten steilen Absturz gebildet. Am 27. Juli war der See mit schmelzendem, grünen Prisma-Eis bedeckt, die Temperatur des Wassers war 1,5, und das Plankton sehr spärlich. Folgende Organismen wurden notiert: *Dinobryon cylindricum*, *Tabellaria* f. var. *flocculosa*, *Keratella hiemalis*, *Notholca squamula* — selten, *Polyarthra dolichoptera*. Die Probe enthält ausserdem kleine, in konserviertem Zustand unbestimmbare Flagellaten.

Palosuo Ice Lake.

Der See liegt südlich des Tales mit Green Ice Lake und ist von diesem durch einen etwa 100 m breiten Moränenwall getrennt. Die Abmessungen des Sees sind 150 · 250 m, seine grösste Tiefe ist etwa 18 m. Er liegt 46 m ü.d.M. Am 19. August kam immer noch etwas Eis im See vor, die Temperatur des Wassers war am Strande 3,2° und draussen im See in der Nähe des schmelzenden Eises 1,9°. Das Plankton war von *Diatoma elongatum* und *Polyarthra dolichoptera* dominiert. Die Frequenz des ersteren nimmt mit dem Abstand vom Ufer ab. Ausserdem kamen vor: *Peridinium inconspicuum*, *Dinobryon cylindricum* var. *paucistre*, *Meridion circulare*, *Tabellaria* f. var. *flocculosa*, *Ankistrodesmus falcatus*, *Chlamydomonas planctogloea*, *Gonatozygon aculeatum*, *Staurastrum punctulatum* var. *striatum*, *Staurastrum sebaldi* var. *ornatum*, *Euchlanis incisa*, *Keratella hiemale*, *Lepadella patella*.

Die folgenden zwei Seen liegen ganz am Rande des Inlandeises—West Ice—und erhalten vom Eis grosse Mengen von Schmelzwasser.

Glacial Lake.

Der eine Strand des Sees wird durch den Eiswall am untersten Rand des West Ice gebildet. Am Eiswall ist die Tiefe des Wassers 15—20 m, in grösserer Entfernung vom Eis ist der See viel seichter, 3—5 m tief. Die Abmessungen des Sees sind 300 × 200 m. Er liegt 92 m ü.d.M. Am 6. August war die Temperatur des Wassers nur 1,1° und das spärliche Plankton wurde von *Dinobryon cylindricum* dominiert. Von folgenden wurden ausserdem vereinzelte Exemplare notiert: *Peridinium inconspicuum*, *Keratella hiemalis*, *Polyarthra dolichoptera*.

Dead Lake.

Der See misst etwa 800 × 1200 m und liegt zwischen West Ice und DE GEER, Toteis und ist somit auf zwei Seiten von Eis begrenzt. Seine Tiefe ist wenigstens 20 m und seine Oberfläche liegt 110 m ü.d.M. Am 8. August waren zwei Drittel des Sees mit Kristalleis bedeckt, das wahrscheinlich im Sommer nicht ganz schmilzt, da die

Abkühlung durch die beiden bis an die Wasseroberfläche reichenden Gletscher dies verhindern können dürften. Die Oberflächentemperatur des Wassers war nur $0,5^{\circ}$ und im Plankton fanden sich spärlich: *Merismopedia punctata*, *Dinobryon cylindricum*—selten, *Gonium sociale*, *Cosmarium microsphinctum* (L. $47,5 \mu$), *Staurastrum senarium*, *Keratella hiemalis*, *Polyarthra dolichoptera*, *Synchaeta lakowitziana*, Nauplien.

Es ist von Interesse, das reichliche Vorkommen von Chironomiden auf dem Wasser der Eisspalten zu notieren. Derartige Mengen sind in keinem der untersuchten Seen beobachtet worden.

Celsius Ice Lake.

Der folgende See liegt am Fuss des Mt. Celsius bei Snaddvika.

Der See liegt 70 m ü.d.M., etwa 900 m vom Fjord im Westen, in den er sein Wasser durch einen kleinen Bach ergiesst. Im Verhältnis zu seiner geringen Grösse (200×350 m) und mit Rücksicht auf seine Lage ist er recht tief (18 m). Am 10. August war die Wassertemperatur an der Oberfläche $5,2^{\circ}$ und das Plankton wurde von *Cyclotella comta* dominiert. Ausserdem wurde notiert: *Merismopedia glauca*, *Peridinium inconspicuum*, *Diatoma elongatum*, *Gloeococcus Schroeteri*, *Botryococcus braunii*, *Polyarthra dolichoptera*, *Synchaeta* sp.

Zum Schluss kommen die drei sogenannten Triple Lakes bei Sälodda, die eine Kette mit dem Ausfluss in den Fjord bei Snaddvika bilden.

Devil Lake.

Dieser See ist von den dreien der grösste, 400×300 m, und liegt wie die beiden folgenden in einem kesselförmigen Becken. Er liegt 9,3 m ü.d.M. und entleert sich in den folgenden See. Die Temperatur des Wassers war bei der Probenahme am 12. August $6,3^{\circ}$. Das Plankton, das von *Uroglena americana* dominiert wurde, bestand aus folgenden Planktern: *Oscillatoria* sp., *Dinobryon sociale*, *Uroglena americana*, *Diatoma elongatum*, *Tabellaria* f. var. *flocculosa*, *Pediastrum boryanum*, *Pediastrum boryanum* var. *longicornis*, *Cosmarium botrytis*, *Cosm. margaritifera*, *Cosm. turpinii*, *Staurastrum lunatum* var. *planctonicum*, *St. sebaldi* var. *ornatum*, *Argonotholca foliacea*, *Kellicottia longispina*, *Keratella hiemalis*, *Polyarthra dolichoptera*, *Chydorus sphaericus*.

Bird Lake.

Dieser See ist etwas kleiner als der vorhergehende. Er misst 250×200 m, seine grösste Tiefe ist 9 m. Sein Boden besteht zum grössten Teil aus Lehm. Der See liegt 3,6 m ü.d.M. und entleert sich in den folgenden See. Auf den Ufersteinen im Wasser wächst *Tribonema*

sp. und eine kleine *Ulothrix* sp. (Br. 9—16 μ). Die Temperatur des Wassers war am 12. August 7,2°. Das Plankton wurde von *Uroglena americana* dominiert. Ausserdem wurde notiert: *Dinobryon sociale*, *Cyclotella antiqua*, *Diatoma elongatum*, *Pediastrum boryanum*, *Closterium lunula*, *Cosmarium holmii*, *Cosm. turpinii*, *Staurastrum avicula* — WEST's Monograph, T. 133, Abb. 10, *St. borgeanum*, *St. lunatum* var. *planctonicum*, *St. petsamoensis* var. *minus* fa., *St. sebaldi* var. *ornatum*, *Argonotholca foliacea*, *Collotheca libera*, *Kellicottia longispina*, *Keratella hiemalis*, *Polyarthra dolichoptera*, Nauplien.

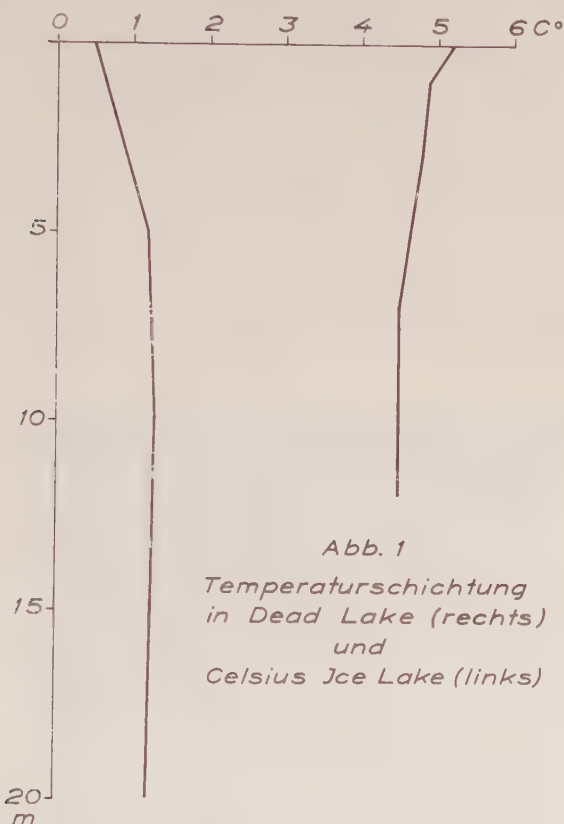
Lake Bullet.

Dieser See ist von den Triple Lakes der am tiefsten gelegenen (2 m ü.d.M.) und entleert sich in den Fjord durch einen 40 m langen Bach. Das nördliche, gegen das Meer zu gelegene Ufer ist niedrig, das südliche hoch und sehr steil, mit bis zum Wasser absteigendem, liegen gebliebenem Schnee. Der See misst etwa 300 × 200 m, seine grösste Tiefe ist 13,5 m und der Boden besteht aus Stein, Moräne und Lehm. Am 12. August war die Temperatur des Wassers 8,6°. Das Plankton wurde von *Uroglena americana* und *Polyarthra dolichoptera* dominiert. Subdominant waren *Staurastrum sebaldi* var. *ornatum*, *Cosmarium turpinii* und *Staurastrum lunatum* var. *planctonicum*. Im übrigen wurde notiert: *Coelosphaerium naegelianum*, *Dinobryon sociale*, *Tabellaria* f. var. *flocculosa*, *Ankistrodesmus falcatus*, *Pediastrum boryanum* var. *granulatum* — benthisch, *Cosmarium botrytis*, *Cosm. margaritifera*, *Cosm. quadratum* — selten, *Gonatozygon pilosum*, *Staurastrum alternans*, *St. brebissonii* var. *maximum*, *St. hexacerum*, *Staurodesmus cuspidatus*, *Argonotholca foliacea*, *Kellicottia longispina*, *Keratella hiemalis*, *Chydorus sphaericus*, Nauplien.

Unter den Gewässern des Nordostlandes kommen nach dem thermischen Verhalten sowohl polare als temperierte Seen vor, wenn man FOREL's Einteilung folgt. Diese beiden Typen werden durch die nebenstehende Darstellung der Temperaturschichtung in zwei der untersuchten Seen illustriert. Celsius Ice Lake zeigt die für polare Seen charakteristische verkehrte Schichtung, während die Temperaturschichtung im Dead Lake die für temperierte Seen während des Sommers charakteristische direkte Schichtung ist.

In den untersuchten Seen wird das Phytoplankton durch die Dominanz der *Chrysophyta* charakterisiert, während die übrigen Algengruppen quantitativ eine untergeordnete Rolle spielen. Die Gattungen *Dinobryon*, *Uroglena*, *Cyclotella* und *Diatoma* wurden als im Phytoplankton vorherrschend notiert. Im grossen ganzen ist das Plankton sehr spärlich, besonders in den tiefen Gewässern, in denen die Temperatur des Wassers gewöhnlich niedrig ist. In den seichten Wässern, die oft eine relativ hohe Temperatur haben, treffen wir ein

quantitativ reicheres Plankton, dessen oft relativer Reichtum an Arten hauptsächlich auf dem Einschlag tychoplanktischer und benthischer Organismen beruht.



Ein Vergleich der Gewässer des Nordostlandes z.B. mit denen West-Grönlands (BACHMANN, 1921) zeigt, dass in den Seen des Nordostlandes die planktische Algenflora viel ärmer ist. Ein Vergleich der Wassertemperaturen ergibt, dass sie in den entsprechenden Gewässern des Nordostlandes durchgehends niedriger sind. In beiden Gebieten spielen die *Chrysophyta* eine bedeutende Rolle und besonders *Dinobryon* und *Uroglena* sind in beiden von Bedeutung. Für mehr eingehende Vergleiche eignet sich die eben genannte Arbeit BACHMANN's nicht.

Zusammenfassungsweise ist zu bemerken, dass *Ceratium* und die grossen Arten von *Peridinium* im Plankton der Gewässer des Nordostlandes, wie es sich in dem oben behandelten Material abspiegelt, fehlen. Die Abwesenheit der weit verbreiteten *Keratella cochlearis* ist geeignet Verwunderung zu erregen, jedoch dürfte die

Art innerhalb des Gebietes vorkommen, da in zwei Proben Panzer dieser Art beobachtet worden sind. Desgleichen wurden von *Bosmina coregoni* nur Schalenfragmente beobachtet.

Im Vergleich mit den am höchsten gelegenen Seen Skandinaviens entbehrt *Tabellaria* f. var. *flocculosa* in den Gewässern des Nordostlandes aller Bedeutung und ist wahrscheinlich tychoplanktisch. Dagegen stellt *Dinobryon* im Plankton der Seen des Nordostlandes meistens eine quantitativ bedeutende Komponente dar, während es in den am höchsten gelegenen Seen Skandinaviens selten ist. In den etwas tiefer gelegenen Hochgebirgsseen Skandinaviens, z.B. Fantesteinvatn (1408 m ü.d.M.) und Tyn (1078 m ü.d.M.), beide in Jotunheimen, bilden die planktischen *Staurastrum*-Arten eine charakteristische Komponente des Planktons. Sie fehlen in den Gewässern des Nordostlandes, abgesehen vom Vorkommen von *Staurastrum sebaldi* var. *ornatum*.

Überhaupt er bietet das Plankton in den Seen des Nordostlandes einen sowohl in quantitativer als in qualitativer Hinsicht sehr dürftigen Eindruck. In den meisten Fällen besteht es aus einer einzigen Phytoplanktonkomponente, zu der sich eine Zooplanktonkomponente gesellt, während alle übrigen notierten Plankter quantitativ ohne jede Bedeutung und oft tychoplanktischer oder benthischer Herkunft sind.

Die Seen des Nordostlandes er bieten ein schönes Beispiel für THIENEMANN'S zweites Grundprinzip der Biozönotik: „Je mehr sich die Lebensbedingungen eines Biotopes vom Normalen und für die meisten Organismen Optimalen entfernen, um so artenärmer wird die Biozönose, um so charakteristischer wird sie, in um so grösserem Individuenreichtum treten die einzelnen Arten auf“. Natürlich müssen die Biozönosen aller Seen nicht einen einheitlichen Charakter aufweisen, da infolge der Verschiebung der Temperaturverhältnisse ins Pejus von dem Grundstock vorher gemeinsamer Arten, aus denen die Planktongesellschaften der temperierten oligotrophen Seen gebildet werden, hier die einen, dort die anderen erhalten bleiben. Dieser Prozess lässt sich verfolgen bei einem Vergleich der Planktongesellschaften in den skandinavischen Hochgebirgsseen mit geeigneten Seen in niedriger Lage, und beim Vergleich arktischer Seen mit geeigneten Seen innerhalb der temperierten Zone.

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Hubert Kufferath

by

P. VAN OYE.

The Belgian algologist HUBERT KUFFERATH died in Brussels on December 17, 1957. He was born in Brussels on July 10, 1882. The family KUFFERATH is well-known in Brussels. It counted several artists, scientists and authors.



Hubert was the son of a physician, professor at the University of Brussels. He started his secondary studies in Brussels and finished them at Ostend. The young man became an agricultural engineer of

the Gembloux institute in 1903. Being there under the leadership of E. MARCHAL, he took interest in bacteriology. He also worked under BORDET, who was to receive a Nobel Prize, and at the same time he prepared his doctor's thesis of biology. His teachers were: MASSART, ERRERA, LAMERE, BOMMER, a.o.

He worked at the Pasteur institute in Brussels and in 1910 he took his doctor's degree in biology with a study on the physiology of Algae.

After the First World War, in 1920, he worked at the new inter-communal laboratory for the control of food, especially milk.

His work of more international value concerns Algae from Belgium and Belgian Congo.

The algological works of KUFFERATH reflect the great honesty of this man. When he made a mistake, he himself corrected all the copies of his reprints.

His publications reach the number of 112 and treated predominantly questions of milk, milk research, hygiene of milk etc., and also beer. Yet 54 of them were devoted to algology. Of these we are giving herewith a complete list. As the reader will see, the interest of KUFFERATH first went to Belgian algology and afterwards to the algology of Belgian Congo.

On late years he planned the formation of an international file of Algae and he had an excellent idea which he carried out in his last works. Of all the plates and figures a second print was included in the publication so that the reader directly could take KUFFERATH's figures and put them in his own file.

This certainly is a system that ought to be developed.

Perhaps the great reviews will follow the example.

As to his African work, it will always be a pity that KUFFERATH had never been himself in Congo and consequently could not know the biotops from where came the material he examined. For the study of algology in Belgium and Belgian Congo KUFFERATH has done a pioneer's job.

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MAX VOIGT: „Rotatoria — Die Rädertiere Mitteleuropas”

I. Textband mit 27 Textabbild. 508 S.

II. Tafelband mit 115 Tafeln

1957 Gebrüder Bornträger, Berlin, Nikolassee, 78 D.M.

This book is a complete survey of all the Rotatoria that are known in Europe. It came at the right moment, not that it wants to be a thorough study of the Rotatoria, but it brings together anything known on the different species of these animals. It is more a prodrome of this group than a systematical thoroughly treated monography.

VOIGT states without any discussion the present knowledge on the Rotatorian species. We know that up to now the systematics of Rotatoria have been one of the most chaotic since the synopsis of HERRING appeared in 1913. We also know that the most used fauna is “Heft 14” of „Die Süßwasserfauna Deutschlands” of COLLIN, DIEFFENBACH, SACHSE & VOIGT (that appeared in 1912, so that the new nomenclature is not used in this book), that the work of REMANE „Bronn’s Klassen und Ordnungen des Tierreiches” (that appeared in 1933) is not yet completed and even did not start with the most difficult orders.

Consequently it had become a necessity of having a complete book on this group of animals. Now the hardest work is done and anyone doing biological and ecological research will be able to determine the species he encounters with great accuracy. Systematians can make systematical reviews. They have an excellent base to start on. Let us hope that within short we will dispose of a large critical study that also gives a definite analysis of every Rotatorian species.

For the moment being the work by MAX VOIGT is the most complete and the most useful of all available “determinating” books. It will be for years to come also the most used. It surely will bring more order in this group that in so many respects is subject to controversy.

P. v. O.

HANS-ERICH KLOTTER: Grünalgen (Chlorophyceen)

Einführung in die Kleinlebewelt.

Kosmos-Verlag, Franckh, Stuttgart, 76 p. D.M. 7.80.

This small book gives a good survey of the Chlorophyceae. The author had less difficulties to cope with than the authors who treated the other groups in the series, for the Chlorophyceae are well defined and the number of species in every genus is not as large. If you do not want to go into the very last details — which is for specialists — „Grünalgen” is quite satisfactory.

Nonetheless there is a difficulty that KLOTTER solved, namely to know if some green algae are Chlorophyceae or not: the author gives on p. 71—73 the most frequent Desmids and green flagellates, so that the user knows at once how to make the distinction.

P. v. O.

FRIEDRICH HUSTEDT: Kieselalgen (Diatomeen)

Einführung in die Kleinlebewelt.

Kosmos-Verlag, Franckh, Stuttgart. 70 p. D.M. 7.80.

HUSTEDT's book will be of great value to beginners. It is compact and reliable and provides a clear introduction to the diatoms.

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NINTH INTERNATIONAL BOTANICAL CONGRESS

The Ninth International Botanical Congress will be held in Montreal, Canada, from August 19 to 29, 1959, at McGill University and the University of Montreal, and will be preceded by sessions of the Bureau of Nomenclature from August 16 to 19

PROGRAM

The program of the Congress is being organized and tentatively includes the following sections:

Nomenclature

General Systematics (including special problems) and
Phylogeny

Taxonomy and Geography of Vascular Plants

Phycology

Mycology (including Medical Mycology)

Phytopathology (including Virology)

Bryology

Lichenology

Microbiology

Morphology and Anatomy

Paleobotany

Physiology

Ecology

Cytology and Genetics

Forest Botany

Ethnobotany and History of Botany

The Second Circular will give instructions as to the length of abstracts and other details. Abstracts of contributed papers must be with the Secretary-General, IX International Botanical Congress, Science Service Building, Ottawa, Canada, by March 15, 1959. **Please do not send abstracts until you receive the Second Circular.**

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